The FOUNDRY

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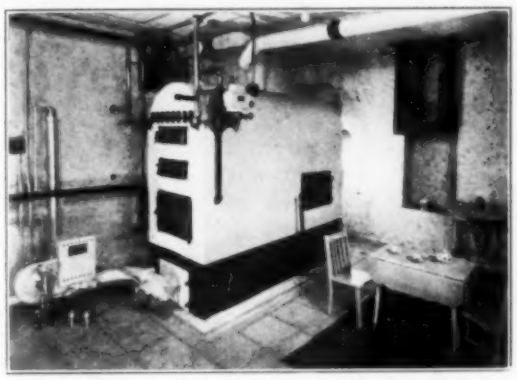
Let Castings Induce the Heat When Winter Winds Blow

ABOUT this time of the year when the first cool breezes of autumn tell of the close of summer, home owners begin to think of the winter's heating problems. The type of fuel to be used is an important factor for consideration and in recent years many installations of oil burning equipment



Courtesy Oil Heating Institute
Oil Heating Equipment Eliminates Much of the Work Associated with Operating the Furnace

have been made. Considerable progress has been made in the development and perfection of oil heating units for domestic use. The modern burner is a mechanical draft unit with air for combustion supplied by a fan or blower. The fuel, which is stored in a large tank usually placed under ground, is prepared for combustion either by atomization or a combination of atomization and vaporization within the burner. Another type of burner, known as the natural draft vaporizing type, requires a high grade of fuel oil and depends on the draft of the chimney for air supply. While both boilers and warm air furnaces especially designed for oil heating equipment now are on the market, most of the oil burners now in use are installed in heating plants originally designed for coal. As in the case of practically all heating equipment, the foundry plays an important part in the construction of oil burning equipment, since many types are designed and constructed chiefly of cast parts.

Find Where Castings Can Be Sold.

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Fig. 1 (Left)—All Boilers to Be Exported Are Assembled and Tested Before Shipping. Fig. 2 (Below)—One of the Units Used in the Plate Foundry Employs Hard Iron Plates, Attached to Chains, which Slide on Rails.

Mechanized
Feature Largest B

By Edwin Bre

PHENOMENAL in every way has been the growth of the automobile industry during the past decade. Due to this rapid rise of the industry, it has attained and held the leadership in advanced methods of manufacture, and the efforts to obtain the maximum production to meet the seemingly insatiable demand for automobiles. Consequently, when any reference to mass production methods is made, the automobile industry takes first place in both the popular and industrial public mind.

This immense industry was not developed overnight nor in a few years. Before automobiles could be produced on the present scale, a demand had to be created. This required careful planning to engage facilities of factories with increasing output. Equally essential was the establishment of a country-wide sales force fully informed on the utility of its product. The sales force, in conjunction with judicious advertising, by degrees impressed firmly upon the public mind the advantages not to say absolute necessity of the automobile to every person's happiness and daily efficiency.

In time the flow of orders to the factories increased. At first the old methods of production in vogue were able to meet the demand, but as orders steadily kept rising these methods were not able to maintain the supply at a satisfactory point. Radical changes then were made from which the present system of production methods was evolved.

In all this radical change, the foundry kept step. Cylinders which taxed the ingenuity of the best molders in 1905 today are produced by the thousands. Perhaps the general axiom of the industry induced progress in automotive foundries, but it is true beyond argument that had the foundries lagged to any extent, all automobile production would have suffered greatly.

Briefly, mass production as applied to the foundry consists in the employment of machines for molding, various types of conveyors for moving molds and castings, sand handling systems, cupola charging machines, continuous core ovens and every known appurtenance that permits maximum production from minimum floor space.

The various production aids mentioned husband the strength of the worker and allow him to produce the largest quantity of finished work with the least amount of effort and also eliminate the human equation as much as possible. They provide uniform castings that will meet the quality specified such as never would be possible with the methods of twenty years ago. In other words, castings are standardized and made with such precision that the variation practically is undetectable.

While modern production methods had their inception in the automobile industry, they rapidly

Fig. 3 (Below)—Cores for Large Boiler Sections Are Made on Jolt Rollover Molding Machines. Fig. 4 (Right)—Sections Are Ground Between Two Large Abrasive Wheels to Insure Parallel Surfaces on the Front and Back

Operations of a Modern Boiler Foundry

Edwin Bremer

are spreading to other specialty foundries. Notable among the latter are the various plants of the American Radiator Co. In 1924, C. M. Woolley, chairman of the board, and Andre Mertzanoff, vice president and general manager, American Radiator Co., New York, after studying the situation, decided that production methods followed in automotive foundries could be applied successfully to the manufacture of radiators and boilers. These executives established new policies to modernize production methods in the company's various foundries.

The firm possessed an extensive, country-wide sales force backed by intelligent merchandising policies which had developed a wide market for its products. The ever increasing construction of new buildings, remodeling of factories, office buildings and homes offered a still larger need which demanded greater production. In addition Mr. Woolley and Mr. Mertzanoff realized that by minimizing the human element as much as possible the products of their firm could be produced with greater precision than heretofore.

As previously stated, the new policy was established in 1924, and the various plants began to install conveyor equipment and labor saving machinery to facilitate production. However, it took some time before the plants were completely equipped, as the regular production schedules in the plants had to be maintained while changes were being made. Just how this was accomplished would be an interesting story in itself, but the main interest for foundrymen lies in the present day method and equipment used. To show these, a description of the various departments of the Bond plant of the American Radiator Co., Buffalo, will be presented, first in brief and later in detail.

This plant originally was opened in September, 1902, with a force of 150 men and a yearly production of 1500 tons of finished cast-iron boilers. At present about 2200 men are employed. In 1927 the production was 85,000 tons, and for 1928 the production is expected to reach 125,000 tons. To make a more striking comparison it is stated that in 1928 more heating units will be manufactured than were produced during the first 13 years of the plant's operation. Approximately 24 carloads of boilers and parts are shipped from the plant each working day.

The Bond plant occupies a tract of 26 acres, in the Black Rock section of Buffalo. It is one of the largest foundries in the world with its melt of 800 tons of metal a day, and is the largest foundry devoted to the production of cast-iron, steam and hot water heating units. In addition to the foundry department, the plant includes a water test department where the boiler sections are tested by being filled with water at 100 pounds per square inch pressure, a completely equipped shop for making master wood patterns and a grinding department where the joint ribs

on the faces of the boiler sections are faced to insure perfect fit.

The plant also operates a machining department where the sections are drilled and tapped, and the holes for water connections between the boiler sections into which tapered nipples are fitted are reamed accurately to size. These departments are supplemented by a machine shop devoted to plant repair, a tool making shop where all reaming and tapping cutters used by the firm are made, and a large wood shop which supplies all boxes for the shipment of boiler parts.

The foundry department is divided into three sections. One is devoted to the production of what is known as plate work, consisting of such parts as doors, smoke hoods, and other small boiler parts. The other two foundry divisions produce boiler sections of various sizes. The plate foundry is supplied with molten metal from one of two cupolas manufactured by the Whiting Corp., Harvey, Ill. These are used on alternate days. Each cupola operates continuously during the 9-hour day and melts between 125 and 150 tons of metal during this period. Charging crane using bottom dump buckets delivers coke and iron. Buckets are placed on pit-type scales and the pig iron, remelt and scrap, each in the proper quantity, are dumped in. The operator in the cab then hoists the bucket to the charging floor, and thence delivers it into the cupola. While this is taking place another bucket is loaded with coke and the proper amount of limestone placed on top. After the operator lowers the empty bucket on the scale, he picks up the coke split and places it in the cupola. This procedure is followed throughout the charging period.

Molds in this shop are made on two distinct types of mold handling units. One employs roller conveyors manufactured by the Mathews Conveyor Co., Ellwood City, Pa., and the two use the chain and sliding plate system developed by the Link-Belt Co., Chicago. The system employing the roller conveyors is arranged in a long rectangle. Seven pairs of molding machines manufactured by the Davenport Foundry & Machine Co., now made by the Milwaukee Foundry Equipment Co., Milwaukee, are placed along one long side of the rectangle, and the conveyor flights about 50 feet long at right angles to the side extend to the shakeouts at the other long side.

Molds are poured on each flight and when the molds reach the end of the flight, they are shaken out by hand. The sand and castings drop upon a long apron conveyor about a foot below the floor level and are carried to the main shakeout. Just before reaching this shakeout, the apron conveyor elevates the sand and castings about 8 feet and then they drop upon a jar screen or grizzly. The fall and action of the screen remove all loose sand from the castings, which drop on another short apron conveyor traveling at right angles. Castings on this conveyor go to the rotary sandblast table manufactured by the Pangborn Corp., Hagerstown, Md., or are taken off the conveyor and sent to a bank of 7 tumbling mills built by the Whiting Corp., Harvey, Ill.

Sand shaken from the castings drops through the openings in the jar screen and is elevated to the sand reclaiming unit manufactured by the Link-Belt Co., Chicago, where it is aerated and tempered. This sand is conveyed overhead to hoppers located above each molding machine. Automatic gates on the hoppers admit a definite amount of sand to be placed in the flask by pulling a lever just above the molding machine.

Adjoining this mold handling machine at the lower end is another similarly arranged, but using a different method of molding. This method is known as drag-plate molding. This mold handling unit contains 6 pairs of molding machines made by the previously mentioned firm. The drag mold is made upon a plate supplied by the Wadsworth Core Machine & Equipment Co., Akron, O., and does not use a flask. The sides of the sand mold are tapered in at approximately 30 degrees instead of being vertical, and this makes the joint between the sand in the cope which is tapered in the opposite direction. The cope is made in a flask supplied by the Sterling Wheelbarrow Co., Milwaukee, which rests directly on the drag plate.

Across the main gangway from the previously mentioned mold handling system is another type known as the merry-go-round. This system, manufactured by the Link-Belt Co., Chicago, employes a chain to which

Fig. 5—All Molding Sand Used in the Various Foundries of the Plant Is Made Synthetically from Partially Burnt Core Sand and Clay

equally spaced plates are attached. These plates slide upon light rail sections on either side of the chain. This unit is about 20 feet across and 70 feet long. In the center of the unit 12 squeezer-type molding machines by the Tabor Mfg. Co., Philadelphia, are placed.

Molds are poured along one short end, and the molds travel along the other side to cool. At the opposite short side of the unit, molds are shaken out by one man upon a shaking screen which has a slight slope away from the mold conveyor and is at right angles to the line of travel. The molding sand drops through the circular openings of the screen upon a cross conveyor belt. The cross conveyor belt carries the sand to an elevator which transfers the sand to the retempering apparatus, and from this device the sand is carried overhead to the storage hoppers over each molding machine.

Castings from this system are shaken to the end of the screen where they are picked up by a man with a pitchfork and placed in large, circular, steel buckets. The buckets are transported by a traveling monorail crane manufactured by the Shepard Electric Crane & Hoist Co., Montour Falls, N. Y., to the tumbling mills at the upper end of the foundry. Empty flasks from the shakeout are returned to the molding stations on gravity roller conveyors.

Adjacent to the mold handling system just described, and parallel to it, is another mold handling system similarly arranged except that it is about half as wide across the narrow dimension. A view of this machine is shown in Fig. 2. As may be seen in this illustration, the molds are poured along one side as distinguished from the other system of pouring at one end. Another differentiation is that the molding machines are placed just outside the conveyor system along one long side opposite where the molds are poured.

This system employes 12 squeezer type molding machines made by the Tabor Mfg. Co., Philadelphia, the same as in the system described previously. Similarly, the molds travel to the upper end of the system and are shaken out upon a shaking screen. Sand and castings are handled as described in the other system.

All molding sand used in the foundries of the Bond plant of the American Radiator Co., is made synthetically from partly burned core sand and a clay sand from the district around Olean, N. Y. This is mixed in the approximate proportion of 70 parts of sand to 30 parts of clay sand. Three to five per cent sea coal also is added depending upon the type of casting to be made. The sand is prepared in muller type sand mixers supplied by the National Engineering Co., Chicago. A view of the synthetic sand department is shown in Fig. 5. Before the sand is placed in the sand mixers, it passes over a vibrating screen supplied by the Link-Belt Co., Chicago, which breaks up the large lumps and removes any extraneous material.

Although some cores still are baked in the regulation type of core oven, the majority are baked in continuous ovens fired by gas and oil. These ovens were developed by the staff of the American Radiator Co. During the travel of the cores through the ovens, they make 4 passes over the burners. Three ovens of this type are used for drying cores. One is 7 feet 8 inches x 19 x 53 feet and the other two are 7 feet 8 inches x 19 x 75 feet. The first mentioned oven is fired by oil and the others are gas fired.

Cores are carried on trays in these ovens which are attached to chains which pass over large sprocket wheels. The sprocket wheels are in hangers which allow them to move vertically. This motion takes care of the expansion and contraction of the chain length. Chain and sprockets for the smaller oven were supplied by the Chain Belt Co., Milwaukee. For the larger ovens, equipment was supplied by the Dodge Mfg. Co., Mishawaka, Ind. One of the gas burners for the larger ovens was supplied by the Surface Combustion Co., Toledo, O., and the other burner was manufactured by the American Radiator Co. Both burners use high pressure gas and by a recirculating system, the gases from baking the cores also are burned to furnish heat. Specifications, layout, erection and installation of all the ovens were directed by the American Radiator Co.

Large cores are made on jolt roll-over type molding machines manufactured by the Herman Pneumatic Machine Co., Zelienople, Pa., and by the Milwaukee Foundry Equipment Co.,

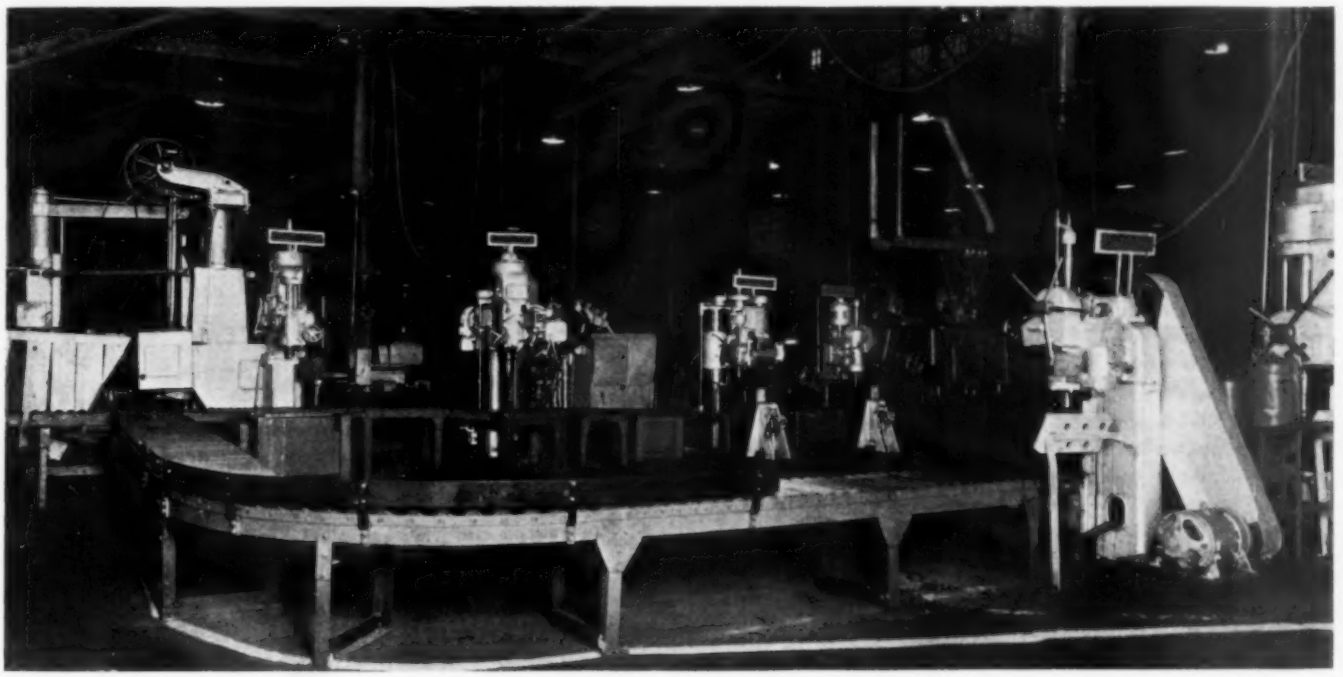

Fig. 6—One of the Straight Line Units Which Drills and Taps the Boiler Sections for Attachment of Parts

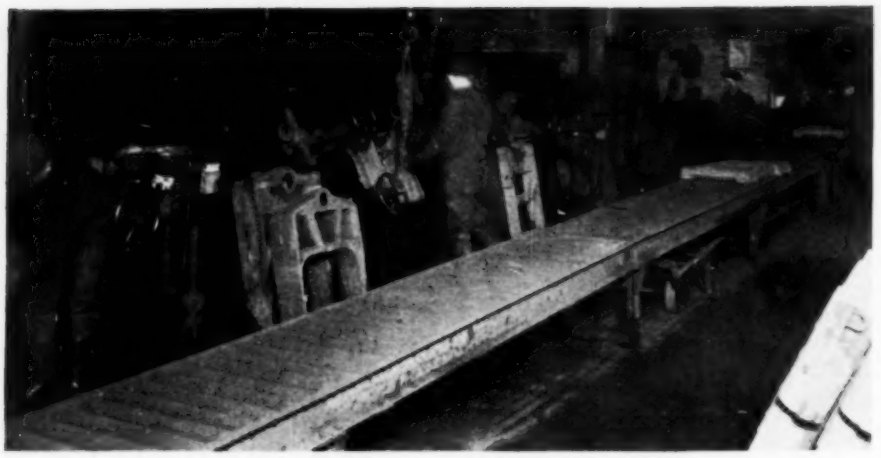

Fig. 7—Boiler Sections Are Tested under 100 Pounds per Square Inch Water Pressure to Eliminate Leaky Castings

Milwaukee. Smaller cores are made on hand, jolt-type molding machines supplied by the International Molding Machine Co., Chicago. The cores when made are turned out on plates manufactured by the Wadsworth Core Machine & Equipment Co., Akron, O. These plates travel on gravity conveyors to the core ovens where they are placed on the trays which travel through the ovens.

Fig. 3 shows the arrangement used at one of the larger gas-fired ovens. This view shows boiler cores on the plates previously mentioned, and the conveyor system. The oven entrance is shown at the left side. Temperature of baking is approximately 500 degrees Fahr., and this is maintained by automatic recording and control apparatus manufactured by the Leeds & Northrup Co., Philadelphia. Boiler cores are baked for approximately two hours, the speed of the chain being such that the passage through the oven occupies this time. Smaller cores are baked about 45 minutes.

Twenty Boiler Units

In the boiler foundries, 20 units are used in producing boiler sections. These units employ jolt, rollover-type molding machines manufactured by the Herman Pneumatic Machine Co., Zelienople, Pa., and by the Milwaukee Foundry Equipment Co., Milwaukee. Each unit contains two machines, one making drags and the other copes. Gravity roller conveyors manufactured by the Mathews Conveyor Co., Ellwood City, Pa., transport the finished molds from the machines and carry the empty flasks from the shakeout to the machines. From 10 to 15 men operate a unit, including molding machine operators, cope and drag finishers, shakeout men and pouring crew. A gang leader is in charge of each unit to supervise operations and lend a hand when necessary. From 8 to 15 molds are produced per hour, depending upon the size of boiler sections made.

Molds are shaken out by two vibrators attached to a yoke. The vibrators are equipped with rings which slip over the trunnions on the flask. The vibrators used were supplied by the Malleable Iron Fittings Co., Branford, Conn. Sand is shaken out over a bar grating in the floor and passes through the openings to a conveyor belt and thence is elevated to the sand handling apparatus. After tempering, the sand is carried overhead on conveyor belts to storage hoppers located above each molding machine. The castings are placed on skids which are carried by truck to the cleaning room.

Metal for the boiler foundries is melted in two cupolas about 500 feet apart. The cupolas are arranged in pairs and are used alternately. One cupola operates 9 hours and melts about 200 tons of iron during this period. The other operates from 22 to 24 hours and melts about 475 tons of metal. Pig iron supplied by the company's blast furnace subsidiary, the Tonawanda Iron Corp., Tonawanda, N. Y., and coke for the cupolas are unloaded directly from railroad cars into bottom dump buckets which are dumped into the cupola. The stock yard is spanned by three cranes, one of which was supplied by the Milwaukee Crane Co., Milwaukee, and the other two by the Whiting Corp., Harvey, Ill.

Minimize Charging Labor

Pig, scrap and remelt are picked up by magnets and placed in a large tilting scoop mounted on a scale. When the proper quantity of each is carried on a larry car by the operator of the car. Coke is unloaded from hopper type gondolas by a portable conveyor directly into the weighing scoop. By this method four men are able to charge 200 tons of metal into the cupola in a day. The men include one on coke, a crane man for the iron, a larry car operator, and a crane operator on the cupola charging device which was supplied by the Whiting Corp., Harvey, Ill.

Core sand is removed from the boiler sections by vibrators supported on air hoists which in turn are suspended from monorail tracks.

After the core sand is removed, the sections are hung on hooks and carried through cabinet type sand-blast machines manufactured by the American Foundry Equipment Co., Mishawaka, Pangborn Corp., Hagerstown, Md., and the Northern Blower Co., Cleveland. Before being sent to the water test department, the castings are inspected for defects. In this department, shown in Fig. 7, the sections are tested by filling them with water at 100 pounds per square inch pressure. As may be seen in this illustration, gravity roller conveyors are used for transporting the castings. During the test the operator knocks off any fins on the section.

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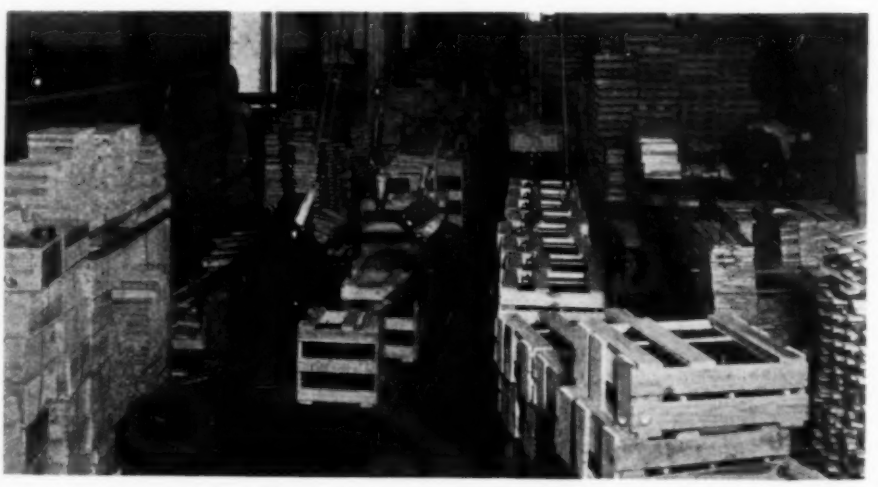


Fig. 8—Doors, Grate Bars, Dampers, Smokehoods, and Other Parts Are Crated on Conveyors, and Shipped with the Boilers

FOUNDRY COUNT

Shows Changing Trends of Industry

Tendency Toward Larger Shops, Mergers and Extensions of Existing Facilities To Increase Unit Production Are Reflected

CHANGES affecting the economic and industrial status of the entire foundry industry are reflected in a compilation of statistics based upon the census of foundries recently completed and published in the new edition of *Penton's Foundry List*. This directory, published by the Penton Publishing Co., Cleveland, gives a complete list of the foundries of the United States and Canada, divided geographically and by kinds of products.

Those who have studied the industry closely during the past two years, the interval since the publication of the last previous roll call, cannot but have noted the tendency toward increased production per unit of man-power. Wherever the addition of new machinery, the rearrangement of existing facilities, or the substitution of new methods could bring increased production, changes have been made to reduce manufacturing costs. Such changes have been made in the face of increased capital expenditure in such cases as promised a reduction in cost over a reasonable time.

This tendency has been accentuated by keen competition, the pressure to reduce castings prices and the general demand for reduction of waste in all industry.

Similarly, a marked step toward consolidation of existing facilities, the reduction of overhead through purchase or merging of existing properties and lowered costs through centralizing manufacture are reflected in these compiled statistics. A broader recognition of the fact that a foundry cannot be operated economically at only a fraction of its capacity has led to shutting down some part time facilities and the removal of the work to other plants, thus supplying the necessary orders to assure operation on a scale which will yield a profit.

These trends all are shown in the tabulations from the 1928 count of foundry plants. A decrease is noted in the total number of foundries in the United States and Canada. The totals taken in the fall of 1926 show 6280 active shops, compared with 6110 on Aug. 15, 1928. On the face of these returns, hasty judgment might hold that the entire industry is facing a decline, but such an assumption is

TOTAL FOUNDRIES IN THE UNITED STATES AND CANADA, BY STATES, AUG. 15, 1928

TOTAL FOUNDRIES IN THE UNITED STATES AND CANADA, 1926

GRAY IRON FOUNDRIES IN THE UNITED STATES AND CANADA, 1928

MALLEABLE FOUNDRIES IN THE UNITED STATES AND CANADA, 1928

shown to be entirely wrong by the known increase in the production and use of castings during the past two years. Those commodities upon which it is possible to make a check, such as sanitary ware, pipe, radiators, etc., show gains, while the great advance in automobile manufacture, the tremendous impetus to building construction, the extensive spread of public service

Table I

Iron and Steel Shops 1928-1926

Total Foundries in the United States and Canada, 1928-1926

United States and Canada, 1928	6,110
United States and Canada, 1926	6,280
Total loss of foundries	170
Foundries, United States, 1928	5,609
Foundries, United States, 1926	5,785
Loss in United States	176
Foundries, in Canada, 1928	501
Foundries, in Canada, 1926	495
Gain, in Canada	6

Gray Iron Foundries in the United States and Canada, 1928-1926

United States and Canada, 1928	4,243
United States and Canada, 1926	4,457
Total gray iron decrease	214
Gray iron, United States, 1928	3,835
Gray iron, United States, 1926	4,044
Loss in United States	209
Gray iron, in Canada, 1928	408
Gray iron, in Canada, 1926	413
Loss in Canada	5

Malleable Foundries in the United States and Canada, 1928-1926

United States and Canada, 1928	204
United States and Canada, 1926	230
Total malleable decrease	26
United States, 1928	189
United States, 1926	214
Loss in United States	25
Canada, 1928	15
Canada, 1926	16
Loss in Canada	1

Steel Foundries in the United States and Canada, 1928-1926

United States and Canada, 1928	369
United States and Canada, 1926	380
Decrease	11
United States, 1928	345
United States, 1926	357
Decrease	12
Canada, 1928	24
Canada, 1926	23
Increase	1

Electric Steel Foundries in the United States and Canada, 1928-1926

United States and Canada, 1928	213
United States and Canada, 1926	199
Increase	14
United States, 1928	195
United States, 1926	182
Increase	13
Canada, 1928	18
Canada, 1926	17
Increase	1

utilities to meet the ever increasing demands of widened city areas, point with equal assurance to the greater consumption of castings in all lines.

Reconciling the slight decrease in the total number of foundries with the tremendous increase in the production and use of castings can be accomplished only through an understanding of those trends toward increased output through improved mechanical equipment, the consolidation of companies and plants, and the waste elimination progress which has been made. Significant of these facts, are the character of many of the replies received to questionnaires which formed the basis of Penton's list. The number of new names added was only 77 less than the number of names

Table II

Nonferrous Foundries 1928-1926

Total Exclusive Nonferrous Foundries and Brass Departments of Other Plants in the United States and Canada 1928-1926

United States and Canada, 1928	3,547
United States and Canada, 1926	3,625
Decrease	78
United States, 1928	3,237
United States, 1926	3,316
Decrease	79
Canada, 1928	310
Canada, 1926	309
Increase	1

Exclusive Nonferrous Foundries in the United States and Canada, 1928-1926

United States and Canada, 1928	1,495
United States and Canada, 1926	1,487
Increase	8
United States, 1928	1,420
United States, 1926	1,421
Decrease	1
Canada, 1928	75
Canada, 1926	66
Increase	9

Nonferrous Departments of Gray Iron, Malleable and Steel Foundries in the United States and Canada, 1928-1926

United States and Canada, 1928	2,052
United States and Canada, 1926	2,138
Decrease	86
United States, 1928	1,817
United States, 1926	1,895
Decrease	78
Canada, 1928	235
Canada, 1926	243
Decrease	8

Foundries Melting Aluminum in the United States and Canada, 1928-1926

United States and Canada, 1928	2,655
United States and Canada, 1926	2,637
Increase	18
United States, 1928	2,424
United States, 1926	2,404
Increase	20
Canada, 1928	231
Canada, 1926	233
Decrease	2

STEEL FOUNDRIES IN THE UNITED STATES AND CANADA, 1928

EXCLUSIVE NONFERROUS FOUNDRIES IN THE UNITED STATES AND CANADA, 1928

TOTAL NONFERROUS FOUNDRIES IN THE UNITED STATES AND CANADA, 1928

removed through plants being reported out of business or idle at the time replies were made. Further, more than 200 changes of name were reported, and many times these name changes indicated a consolidation of interests and centralized manufacturing in one or more of a company's plants with an idle report upon one unit.

This tendency toward concentration in larger plants is shown by a study of the individual states. Those regions which in the past ten years have led in the movement toward large production units, notably Michigan, Ohio, Indiana and Illinois, show the greatest decline in the total number of foundries during the past two years. Those familiar with the trend in automotive lines will recognize the influence of expansion in manufacturer's foundries at the expense of purely jobbing interests, with the centralizing of all lines of production within the plant of each automobile builder in many cases. A similar trend toward large production shops is found in the radiator and sanitary ware branches of the industry.

The influence of transportation charges upon competitive prices is demonstrated by the decline in the number of foundries in many states which formerly drew from a wide territory and the increase in the number

FOUNDRIES OF THE UNITED STATES
1928 and 1926

	Total Foundries 1928	Total Foundries 1926	Increase or decrease in two years	Gray iron foundries 1928	Gray iron foundries 1926	Exclusive nonferrous foundries 1928	Exclusive nonferrous foundries 1926	Nonferrous foundries depart. of other shops, 1928	Nonferrous foundries depart. of other shops, 1926	Total nonferrous foundries 1928	Total nonferrous foundries 1926	Malleable iron foundries 1928	Malleable iron foundries 1926	Steel foundries 1928	Steel foundries 1926	Electric steel foundries 1928	Electric steel foundries 1926	Foundries melting aluminum 1928	Foundries melting aluminum 1926
Alabama	96	97	— 1	87	90	7	5	32	33	39	38	2	2	5	4	4	2	24	26
Alaska	1	2	— 1	1	2	..	..	..	1	0	1	..	..	1	..	1	..	..	..
Arizona	11	9	+ 2	11	9	..	..	10	9	10	9	1	1	2	1	2	1	6	3
Arkansas	17	17	..	17	17	..	..	15	15	15	15	..	..	1	1	1	1	8	9
California	244	228	+16	145	148	78	62	74	80	152	142	5	4	28	24	24	18	112	114
Canal Zone	1	1	..	1	1	..	..	1	1	1	1	..	..	1	1	..	..	1	1
Colorado	47	42	+ 5	34	32	13	10	14	10	27	20	..	..	4	4	2	2	23	16
Connecticut	157	160	— 3	76	76	68	73	38	35	106	108	15	13	5	8	3	2	74	71
Delaware	15	16	— 1	7	9	5	4	6	7	11	11	1	1	2	2	1	1	4	4
Dist. of Columbia	6	9	— 3	4	6	2	2	3	4	5	6	..	..	1	1	1	..	5	6
Florida	24	24	..	22	22	2	2	20	20	22	22	..	..	1	1	1	1	21	20
Georgia	69	74	— 5	64	69	5	5	44	47	49	52	..	..	1	1	1	1	35	32
Hawaii	2	2	..	2	2	..	..	2	2	2	2	..	..	..	..	..	..	1	1
Idaho	10	9	+ 1	10	9	..	..	9	8	9	8	..	..	..	..	..	..	8	7
Illinois	441	467	—26	265	297	123	140	103	109	226	249	29	28	21	26	11	13	178	187
Indiana	231	229	+ 2	161	163	50	48	52	59	102	107	13	17	11	12	3	3	75	88
Iowa	104	99	+ 5	86	85	12	8	46	47	58	55	1	1	6	7	3	3	51	39
Kansas	42	43	— 1	37	39	4	3	29	25	33	28	1	1	..	..	..	..	30	25
Kentucky	48	51	— 3	35	40	12	11	18	21	30	32	..	..	..	..	..	..	23	22
Louisiana	33	31	+ 2	28	25	4	5	21	18	25	23	..	..	6	5	3	3	12	11
Maine	31	30	+ 1	29	27	2	3	21	19	23	22	..	..	..	..	..	..	18	19
Maryland	56	60	— 4	39	42	18	18	21	18	39	36	1	2	1	1	..	..	30	20
Massachusetts	248	265	—17	144	159	92	94	46	57	138	151	3	3	12	14	5	7	112	114
Michigan	367	372	— 5	225	229	112	116	89	112	201	228	14	15	18	14	14	7	149	158
Minnesota	112	109	+ 3	85	80	23	24	51	44	74	68	1	1	6	7	3	3	60	54
Mississippi	21	21	..	21	21	..	..	17	19	17	19	..	..	..	..	..	..	9	10
Missouri	121	133	—12	81	94	34	36	28	33	62	69	2	2	6	8	3	3	46	50
Montana	10	12	— 2	10	12	..	..	10	12	10	12	..	..	..	..	..	..	8	9
Nebraska	27	31	— 4	21	24	8	6	13	14	21	20	..	..	1	1	1	1	19	18
Nevada	5	5	..	4	4	1	1	4	4	5	5	..	..	1	1	1	1	4	4
New Hampshire	30	32	— 2	23	27	6	5	14	16	20	21	1	1	1	1	1	1	15	15
New Jersey	220	248	—28	140	162	69	77	49	67	118	144	6	5	7	8	3	4	89	102
New Mexico	3	3	..	3	3	..	..	3	3	3	3	..	..	..	..	..	..	2	2
New York	494	544	—50	330	363	140	163	172	172	312	335	18	24	16	18	8	11	227	235
North Carolina	67	66	+ 1	64	66	3	..	48	51	51	51	..	..	1	1	..	..	41	43
North Dakota	3	2	+ 1	2	2	1	..	1	1	2	1	..	..	..	..	..	..	1	1
Ohio	603	636	—33	362	386	187	193	117	115	304	308	28	38	37	39	24	20	210	220
Oklahoma	43	35	+ 8	30	28	11	6	13	17	24	23	..	..	1	1	1	1	22	22
Oregon	58	53	+ 5	44	45	9	5	30	28	39	33	1	1	5	4	4	3	37	30
Pennsylvania	728	774	—46	529	560	147	157	220	219	367	376	21	24	81	84	23	29	259	257
Philippine Islands	1	..	+ 1	1	..	..	..	1	..	1	..	..	..	..	..	..	..	1	..
Rhode Island	45	48	— 3	21	22	22	25	11	10	33	35	1	1	..	1	1	1	27	27
South Carolina	19	21	— 2	19	21	9	..	16	18	25	18	..	..	..	..	..	..	10	13
South Dakota	6	7	— 1	6	6	..	1	5	4	5	5	..	..	..	..	..	..	4	4
Tennessee	83	87	— 4	74	77	9	10	36	46	45	56	1	2	2	3	1	1	31	37
Texas	89	82	+ 7	68	67	17	14	39	42	56	56	1	1	8	6	6	4	43	39
Utah	22	18	+ 4	19	16	3	2	10	11	13	13	..	..	2	1	2	1	10	10
Vermont	23	23	..	21	21	2	2	12	10	14	12	..	..	..	..	..	..	10	9
Virginia	75	74	+ 1	71	73	3	..	50	49	53	49	..	1	6	5	5	4	44	38
Washington	91	84	+ 7	64	62	20	15	39	38	59	53	..	2	14	13	12	11	46	43
West Virginia	46	47	— 1	33	39	8	7	21	24	29	31	2	1	4	6	2	3	21	23
Wisconsin	260	250	+10	156	162	79	63	70	68	149	131	20	22	20	21	15	14	125	93
Wyoming	3	3	..	3	3	..	..	3	3	3	3	..	..	..	..	..	..	3	3
Total in U. S.	5609	5785	—176	3835	4044	1420	1421	1817	1895	3237	3316	189	214	345	357	195	182	2424	2404
CANADA																			
Alberta	15	15	..	13	12	2	3	12	12	14	15	1	1	1	2	4	..	12	13
British Columbia	37	32	+ 5	32	27	5	5	22	18	27	23	..	..	3	..	..	2	21	16
Manitoba	15	16	— 1	12	13	2	2	4	6	6	8	..	..	2	2	2	2	6	7
New Brunswick	13	14	— 1	13	14	..	..	12	12	12	12	..	..	..	..	..	..	7	9
Newfoundland	3	3	..	3	3	..	..	2	2	2	2	..	..	..	..	..	..	1	1
Nova Scotia	26	26	..	25	25	1	..	18	20	19	20	1	3	1	1	2	1	13	10
Ontario	281	283	— 2	223	235	47	41	111	120	158	161	11	11	8	8	4	4	112	119
Prince Edward Is	3	3	..	3	3	..	..	2	2	2	2	..	..	..	..	..	..	2	1
Quebec	104	100	+ 4	80	78	18	15	49	48	67	63	2	1	9	10	6	8	54	54
Saskatchewan	4	3	+ 1	4	3	..	..	3	3	3	3	..	..	..	..	..	..	3	3
Total in Canada	501	495	+ 6	408	413	75	66	235	243	310	309	15	16	24	23	18	17	231	233
Total in U. S. and Canada	6110	6280	—170	4243	4457	1495	1487	2052	2138	3547	3625	204	230	369	380	213	199	2655	2637

Table IV

Nonferrous Centers

Standing	City	Total foundries 1928	1926
1	Chicago	101	109
2	New York City	76	73
3	Cleveland	74	61
4	Detroit	66	70
5	Philadelphia	64	67
6	Milwaukee	48	37
7	Boston	42	41
8	Los Angeles	39	39
9	St. Louis	35	37
10	Cincinnati	34	34
11	Toronto	28	19
12	Pittsburgh	27	27
13	San Francisco	26	22
14	Buffalo	25	24
15	Newark	22	25
16	Minneapolis	22	21
17	Baltimore	22	21
18	Grand Rapids	20	17
19	Columbus	20	16
20	Montreal, Que.	20	23
21	Rochester, N. Y.	19	19
22	Portland, Oreg.	17	10
23	Erie, Pa.	17	10
24	Louisville, Ky.	16	13
25	Bridgeport, Conn.	15	17
26	Dayton, O.	15	13
27	Seattle	15	10
28	Racine, Wis.	15	8
29	Denver	14	9
30	Toledo	13	15
31	Providence, R. I.	13	13
32	St. Paul, Minn.	13	10
33	Chattanooga	13	13
34	New Haven, Conn.	12	11
35	Kansas City	12	10
36	Reading, Pa.	12	14
37	Vancouver, B. C.	11	11
38	Worcester, Mass	11	11
39	Lancaster, Pa.	11	10
40	Scranton, Pa.	11	10
41	Spokane	11	10
42	Quincy, Ill.	11	12
43	Syracuse, N. Y.	10	14
44	Trenton, N. J.	10	11
45	New Britain, Conn.	10	10
46	Springfield, Mass.	10	9
47	Jersey City	10	9
48	York, Pa.	10	8

of shops in states hitherto remote from their source of castings supply. In the New England district practically every state shows a loss, while the west coast, the oil regions in the southwest and a few of the southern states show gains.

In the roll call of the states, Pennsylvania again leads. This state, notable for its iron and steel production and its wide variety of manufactured commodities and machinery, has a total of 728 foundries. Ohio with 603, New York with 494, Illinois with 441 and Michigan with 367 maintain the same relative position with regard to the total number of foundries within their borders. Wisconsin has traded places with Massachusetts, moving up to sixth with a total of 260 shops listed in 1928, compared with 250 in 1926. California has advanced from tenth to eighth place, with an increase from 228 shops in 1926 to 244 in 1928. Indiana now is ninth with 231, New Jersey tenth with 220, Connecticut eleventh with 157, and Missouri twelfth with 121. Washington, Oregon and California, the Pacific coast states, all show gains. Similarly, Texas and Oklahoma, recent centers of tremendous expansion in the oil industry, show a greater number of foundries in 1928 than in 1926.

The gain in total number of foundries in Canada with 1928 showing 501, compared to 495 in 1926, has made no change in the relative position of the provinces. Ontario still leads with a total of 281 shops. Quebec is second with 104; British Columbia third with 37; Nova Scotia fourth with 26; and Alberta and Manitoba tie with 15 each.

Among the cities, Chicago with a total of 183 and Cleveland with 121 maintain first and second place on the list of leading foundry centers. Detroit has moved up to third place with Philadelphia fourth and New York fifth. A gain in the number of foundries in Milwaukee has advanced that city from eighth to sixth place ahead of Los Angeles and St. Louis. Three cities of the country have more than 100 foundries, six more than 75, twelve more than 50, fifteen more than 40 and twenty-eight more than 30 shops. The number of foundries in these centers is a measure of industrial activity rather than total population as is shown by the high standing of such

(*Concluded on Page 772*)

Table V

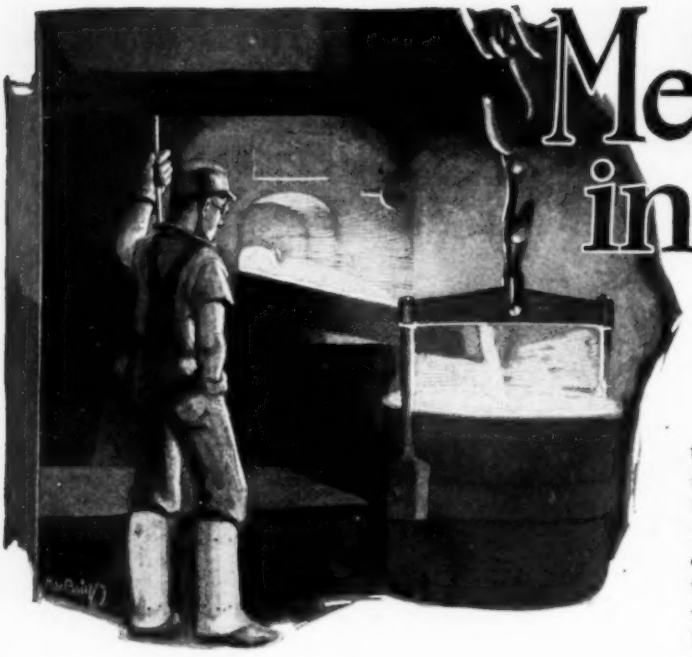
Roll Call of Foundries by States, 1928-1926

Standing	State	1928	1926	Standing	State	1928	1926
1	Pennsylvania	728	774	27	Rhode Island	45	48
2	Ohio	603	636	28	Oklahoma	43	35
3	New York	494	544	29	Kansas	42	43
4	Illinois	441	467	30	Louisiana	33	31
5	Michigan	367	372	31	Maine	31	30
6	Wisconsin	260	250	32	New Hampshire	30	32
7	Massachusetts	248	265	33	Nebraska	27	31
8	California	244	228	34	Florida	24	24
9	Indiana	231	229	35	Vermont	23	23
10	New Jersey	220	248	36	Utah	22	18
11	Connecticut	157	160	37	Mississippi	21	21
12	Missouri	121	133	38	South Carolina	19	21
13	Minnesota	112	109	39	Arkansas	17	17
14	Iowa	104	99	40	Delaware	15	16
15	Alabama	96	97	41	Arizona	11	9
16	Washington	91	84	42	Montana	10	12
17	Texas	89	82	43	Idaho	10	9
18	Tennessee	83	87	44	District of Columbia	6	9
19	Virginia	75	74	45	South Dakota	6	7
20	Georgia	69	74	46	Nevada	5	5
21	North Carolina	67	66	47	Wyoming	3	3
22	Oregon	58	53	48	New Mexico	3	3
23	Maryland	56	60	49	North Dakota	3	2
24	Kentucky	48	51	50	Hawaii	2	2
25	Colorado	47	42	51	Alaska	1	2
26	West Virginia	46	47	52	Canal Zone	1	1

Table VI

Leading Foundry Cities of the United States and Canada, 1928-1926

Standing	City	Total foundries 1928	1926	Standing	City	Total foundries 1928	1926
1	Chicago	183	204	36	Springfield, O.	22	24
2	Cleveland	121	125	37	Worcester, Mass.	22	22
3	Detroit	100	109	38	Kansas City	21	21
4	Philadelphia	98	109	39	Oakland, Calif.	21	19
5	New York	92	111	40	Moline, Ill.	20	19
6	Milwaukee	80	68	41	St. Paul, Minn.	20	17
7	Los Angeles	74	76	42	Providence, R. I.	19	20
8	St. Louis	65	73	43	Vancouver, B. C.	19	19
9	Buffalo	62	65	44	Atlanta, Ga.	18	23
10	Pittsburgh	61	67	45	Canton, O.	18	22
11	Boston (Greater Boston)	61	64	46	Anniston, Ala.	17	18
12	Cincinnati	57	61	47	Hamilton, Ont.	16	17
13	Toronto, Ont.	45	42	48	Rockford, Ill.	16	17
14	Minneapolis	42	40	49	Quincy, Ill.	16	16
15	Newark, N. J.	41	46	50	Trenton, N. J.	16	16
16	San Francisco	38	44	51	Peoria, Ill.	16	15
17	Baltimore	37	42	52	New Haven, Conn.	16	14
18	Montreal, Que.	36	34	53	Evansville, Ind.	15	19
19	Erie, Pa.	35	33	54	Jersey City, N. J.	15	18
20	Dayton, O.	33	30	55	Lancaster, Pa.	15	16
21	Seattle	33	29	56	Muskegon, Mich.	15	14
22	Portland, Oreg.	33	28	57	West Allis, Wis.	15	13
23	Toledo, Ohio	32	35	58	Houston, Tex.	15	12
24	Columbus, O.	32	34	59	Kalamazoo, Mich.	14	17
25	Rochester, N. Y.	31	29	60	Akron, O.	14	15
26	Denver, Colo.	31	28	61	Knoxville, Tenn.	14	13
27	Louisville, Ky.	30	30	62	York, Pa.	13	14
28	Chattanooga, Tenn.	30	28	63	Saginaw, Mich.	13	13
29	Birmingham, Ala.	29	30	64	New Britain, Conn.	13	13
30	Indianapolis	27	28	65	Richmond, Va.	13	13
31	Grand Rapids	26	22	66	Belleville, Ill.	13	12
32	Syracuse, N. Y.	24	30	67	Elkhart, Ind.	13	11
33	Reading, Pa.	24	27	68	Waterloo, Iowa	13	11
34	Racine, Wis.	24	21	69	Scranton, Pa.	13	12
35	Bridgeport, Conn.	23	27	70	Salt Lake City	13	11



Melting Iron in the Cupola

By J.E.Hurst

Part II

LIFE activities of John Wilkinson are illustrative of the rapid development of the iron-founding industry during this period. Born in 1728, he worked with his father at an iron furnace at Backbarrow, near Ulverston, Lancashire, and was afterward in partnership with his brother and father. It is related in connection with this establishment that John's father carried molten iron, a ladleful at a time, across a road to the small foundry, and cast smoothing irons.

John erected an iron furnace at Wilson House, Cartmel, for smelting the local ore of the Furness district. From this starting point, the two brothers erected iron forges at Bersham, near Chester; Bradley, Staffs; Willey, near Rugby; Brymbo, Denbigh; Merthyr Tydvil, and other places. At Bilston, in Staffordshire, John constructed the first blast furnace in this area and utilized the coal of the district in place of charcoal.

Here he made the first iron boat to carry fuel along his canal to the furnaces. In a letter dated Oct. 20, 1787, from his Bradley Ironworks, he wrote, "There have been two iron boats launched in my service since September. My clerk at Broseley advises me that she (they) swims remarkably light, and exceeds even my own expectations."

His activities extended to assisting Boulton and Watt in the application of the steam engine for blowing purposes. He also spent considerable time abroad in France, Belgium and Silesia. At Le Creusot in France, he exploited his method of boring cast-iron cannons, and to this day, the cupola is frequently referred to in France as the *Four Wilkinson*, that is the Wilkinson furnace. Some doubt exists as to whether it was John or his brother William who was employed at Le Creusot. A pamphlet issued by the firm of Schneider at Le Creusot some years ago, stated that they "employed the English engineer William Wilkinson, the inventor of the cupola, to put his system into operation at the works."

John erected the first iron bridge at Coalbrookdale, Shropshire, and his many interests included the coking of coal, coal and tar distillation, gas making, and hot blast for furnaces. So thoroughly was Wilkinson imbued with the merits and utility of cast iron, that he made a cast iron pulpit also cast iron coffins for any who wanted them. He was buried in a cast iron coffin. A cast iron obelisk of his own design, and still in existence, was erected to his memory in the parish of Lindale. Activities of this truly remarkable man serve to illustrate the rapid extension of the iron trade during the 18th century, and it is a fitting tribute to his memory that his portrait should receive prominence in any discussion of cupola practice.

From Wilkinson's general methods it is apparent that the foundries adjoined the blast furnaces, and the molten metal was produced direct from ore smelted in these furnaces. From Wilkinson's patent we may infer that he felt the need for a smaller unit, which would be of greater flexibility in meeting the varying needs of his foundry. This patent distinctly states that his furnace was intended for the direct smelting of ore, but one can hardly imagine that so versatile a genius as Wilkinson did not use his furnace to remelt scrap castings, some of which inevitably must have been produced, even in his advanced foundries.

Rapid extension in the use of iron castings for domestic purposes, in the early stages of the development of the cast-iron industry, placed a lucrative business in the hands of traveling tinkers. These itinerants traveled, in districts remote from blast furnaces, equipped with portable cupolas and molding apparatus. Their business was to remelt and recast, or repair broken utensils, on the spot. The cupola as a furnace for remelting cast iron may have originated with these people. In passing, it may be noted that John Bunyan, the tinker probably belonged to this class of artisans who carried the portable cupola.

Reaumur, about 1720, left a description of the itinerant iron founders of the east of France, who traveled from place to place to undertake the repair

Traces Developments

CONTAINS a historical sketch of John Wilkinson, famous English iron master usually credited with the invention, construction and operation of the foundry cupola as it is known today. Reference is made to the traveling tinkers of the early days who carried a portable foundry around the country and melted iron in small quantities to effect repairs mostly to household and cooking equipment. The Chinese remelted iron in a crude type of cupola over 1000 years ago. The remainder of the chapter is devoted to development of the cupola in the nineteenth century in the hands of Spencer, William and Jonathan Ireland, George Hinton, the Woodwards and Herbertz. Experiments were tried in early days on the utilization of hot blast and all the early melters tried various tuyere arrangements to improve their practice.

of cast iron and general domestic utensils. The furnace was a cast iron pot, lined with clay, with an extended shaft built on the edge. Air was introduced by hand or foot operated bellows. Similar furnaces are stated to have been in use in China for at least 1000 years. A complete description of these cupolas has been published on several occasions in THE FOUNDRY, but there is some uncertainty as to whether the type of furnace described was indeed utilized from the beginning for remelting cast iron.

Outstanding features which emerge from these considerations are that the introduction of the cupola furnace, for the remelting of iron for foundry purposes was more or less gradual and probably originated in this and other countries with the traveling tinkers. Strictly speaking, to describe John Wilkinson as the inventor of the iron-foundry cupola is incorrect. However, broadly speaking, Wilkinson no doubt was the first individual to perceive the necessity for a smaller and more manageable unit than the blast furnace in meeting the demands of organized foundry production. That his cupola, as described in his patent specification, does not comply with our modern restricted definition of the foundry cupola, and the fact that he probably was preceded by itinerant molders does not constitute sufficient reason for withdrawing from him the title of inventor of the foundry cupola.

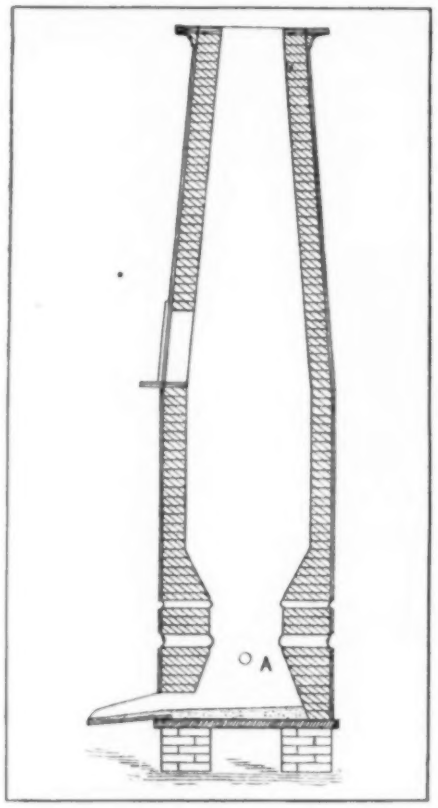


FIG. 6—IRELAND'S DOUBLE TUYERE CUPOLA

Development of the Cupola

After the death of Wilkinson in 1800, and coincident with the rapid industrial development in the early part of the nineteenth century, the foundry cupola received its full share of attention. A brief survey of its development during these years can be traced from the patent records and one cannot help but be struck by the fact that almost every conceivable item in the design likely to improve its efficiency or its adaptability for special purposes, has received attention. The shape of the lining, the shape, position and number of tuyeres, preheated blast, utilization of waste heat, storage of molten metal, desulphurization, all these aspects of cupola design and practice, many of which still figure prominently in the polemics of today, received full measure of attention.

Cast-iron plate construction originated by Wilkinson, was the form adopted by the various iron foundries which rapidly developed throughout England. The internal form was generally cylindrical and lined with good sandstone. These cupolas are still within the memory of many living foundrymen.

Patent No. 5031, dated 1824, in the name of John White (the younger) and Thomas Sowerby is the first patent recorded in the British patent journals, in which direct reference is made to the alternate charging of coke and pig iron. Several patents follow, relating to the design of cupolas operating by natural pressure of the air in place of a blast and by a down draft aided by an exhaust fan.

Utilization of waste heat from the cupola in a separate chamber provided for calcining iron ore was the subject of a patent granted in 1838, and a patent was granted to Richard Stuart Norris in 1851, for a portable cupola, with an arrangement of standards at the top for supporting and preheating the foundry ladles.

First Fore Hearth

A patent of some historical importance, No. 1430, granted to John Spencer in 1853, covered the invention of an arrangement "by the side of an ordinary cupola for melting cast iron, a second cupola or reservoir so arranged that the contents of the two may be either drawn off separately or both from the same tap hole, when a larger amount of iron is required than one cupola would hold." This is probably the first British patent relating to the use of a receiver. In the same year a patent was granted to William Ireland which contains an early reference to an increase in height of the cupola above the usual. The inside was constructed of a taper form " to prevent the metal sticking or crusting to the sides and provides for hot air to be introduced by a fan or blower."

Provisional protection only was granted to William Clay in 1857, for a cupola in which a draft of air was created by an exhausting apparatus communicating with the upper part of the furnace, which was enclosed. The draft may enter the lower part through tuyeres, and sometimes the apparatus may be arranged to produce a downward draft. This appears to be the forerunner of the steam jet operated cupolas, which appeared later.

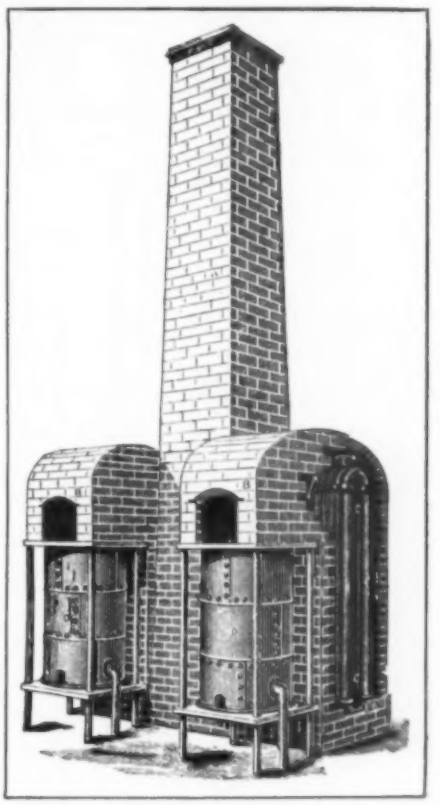


FIG. 7—EARLY TYPE HOT BLAST CUPOLA

Introduction of two rows of tuyeres generally is credited to Jonathan Ireland, apparently the son of William Ireland. This patent was granted in 1858, and covered the application of one or more tuyeres above the ordinary tuyeres, and also the construction of the wind belt within the furnace. A typical illustration of the construction of Ireland's cupola is given in Fig. 6.

George Hinton in 1860, patented a cupola with two or more rows of tuyeres containing 8 tuyeres in each

row, the upper row inclined upward, and the bottom row inclined downward. A separate blast belt was provided for each row of tuyeres. In the same year, Hinton was granted a patent for a portable cupola. Provisional protection was granted in 1861 to Hinton and a collaborator for cupolas sulphurous coke by using alkalies. Bedson, in 1863, designed and patented a system of water cooled boshes, and in 1865, a patent No. 209 was granted Woodward, relating to steam jet cupolas. The Woodward and the Herbertz steam jet cupolas were used extensively in England. The Herbertz on a bogie frame and wheels to facilitate the removal of the hearth and its metal contents from the cupola.

A steam jet supplied with steam at about 80 pounds pressure acting as an injector in the constricted passage illustrated, created an air pressure

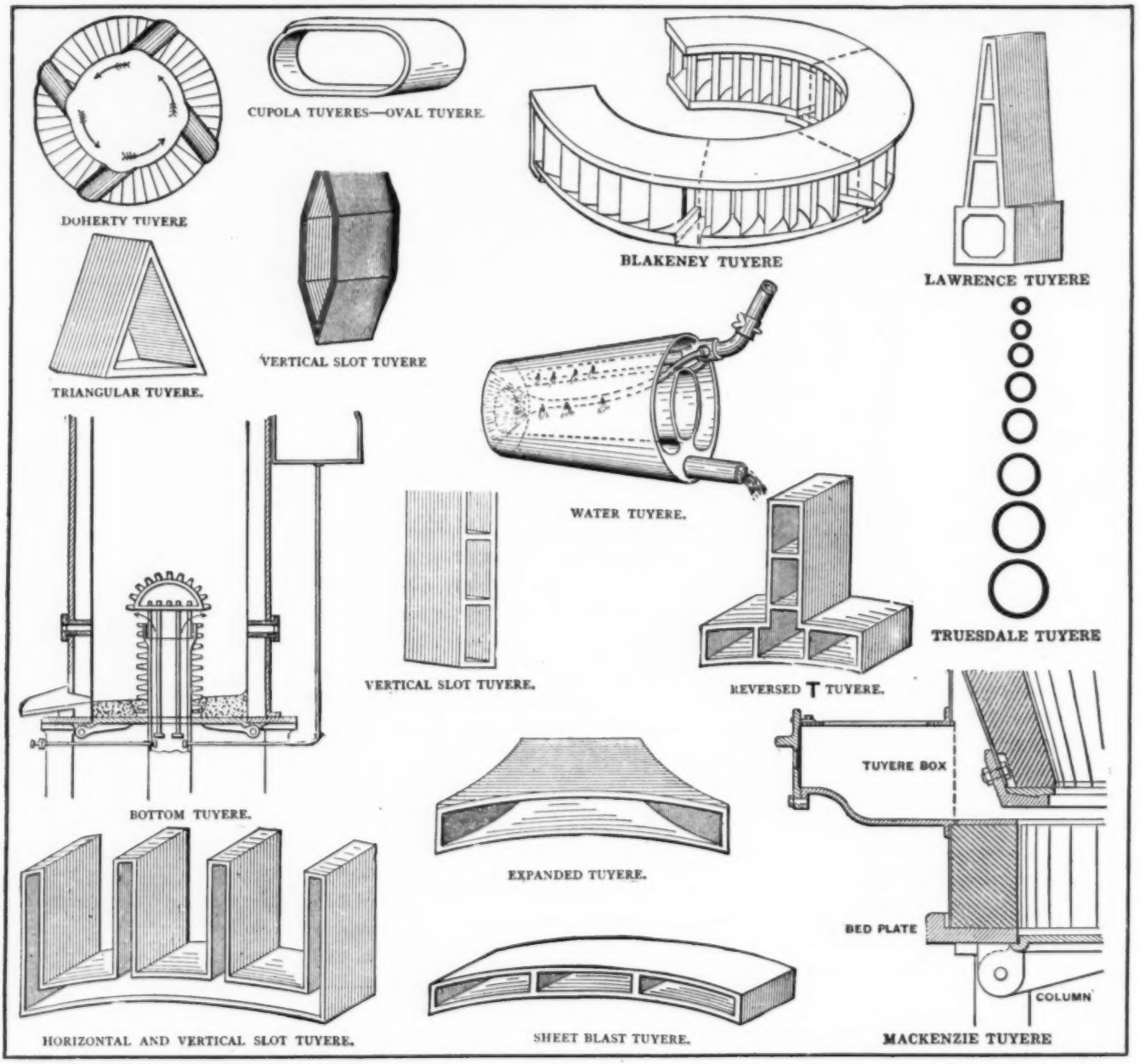


FIG. 8—AT ONE TIME OR ANOTHER PRACTICALL EVERY CONCEIV ABLE SHAPE AND NUMBER OF TUYERES HAVE BEEN TRIED IN THE FOUNDRY CUPOLA IN AN EFFORT TO PROMOTE HIGHER EFFICIENCY

with a hollow space between the brickwork and the outer casing, through which the blast was arranged to be heated. In the same year Charles Jordan patented a method for the application of the waste gases from the cupola for drying and heating molds.

Another patent of some historical importance is that of George Parry, dated 1861, for melting wrought iron in an ordinary cupola. This patent includes the method of purification of steam jet cupola, shown in Fig. 9, was of somewhat more elaborate construction than the Woodward.

The moveable hearth construction clearly shown, was mounted on four adjusting screws operating in nuts carried on the standards of the cupola. These screws regulated the dimensions of the annular opening between the hearth and the body of the cupola through which the air entered. In some designs, the moveable hearth and adjustments were mounted of from 3 to 4 inches of water gage in the cupola. This was claimed to reduce the coke ratio to 4 or 5 per cent. On a similar cupola in the United States Kirk found that the melting coke consumption was 6 per cent.

Comparison of melting rate of this cupola with present day practice is not possible owing to the omission of the melting zone diameter. The fact that a 52-inch external shell diameter is referred to as the dimension of

one of these cupolas having a rated capacity of 2 tons per hour, would appear to indicate that the melting rate of these cupolas was considerably slower than it is today in common practice. A 52-inch shell with a single wall should give an inside diameter of 42 inches.

In a special design of the Herbertz cupola adopted for melting steel the indrawn air entered the cupola by way of wrought iron pipes embedded in the brickwork and parallel to the vertical axis of the furnace. The pipes were open to the air in the outside shell of the furnace and opened into the shaft of the furnace at a point just above the annular tuyere opening of the standard form, which in this design was stopped off. Claim was made that the indrawn air passing through the tubes embodied in the lining was preheated to a temperature between 275 and 600 degrees Cent.

Preheating the air blast appears to have attracted attention from the earliest times and many proposals have been made with this end in view. Coils of pipe have been suspended in the upper portion of the furnace stack. Inlet air passing through these coils was preheated by the hot flames and exit gases. An interesting arrangement described by Kirk is illustrated in Fig. 7. Waste gases pass over cast iron pipes erected in a brick chamber leading to a main chimney. This construction is similar to the boiler house economiser and the blast passing to the cupolas is preheated in its passage through the cast iron pipes.

Shape of the internal lining of the cupola above and below the tuyere level has been varied in almost every conceivable manner. Parallel linings, partially expanded linings above the tuyere level, have been used in a variety of forms. Expansion of the well below the tuyere level to take care of large quantities of metal was the basis of the reservoir cupola of William Ireland.

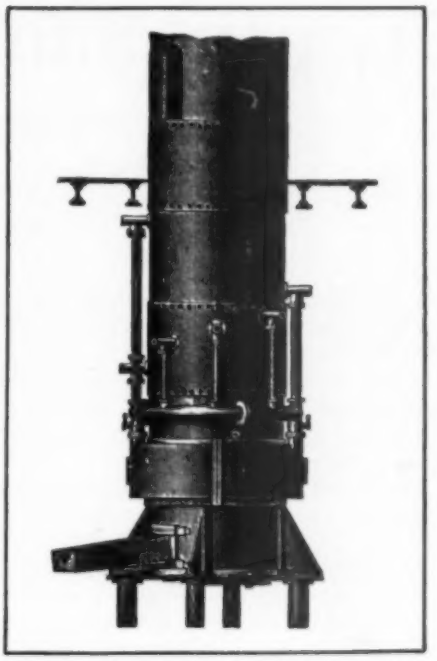


FIG. 10—REGULAR TUYERE BELT IS SUPPLEMENTED BY SEVERAL SMALL PIPES PIERCING THE SHELL AND LINING AT GRADUALLY ASCENDING LEVELS

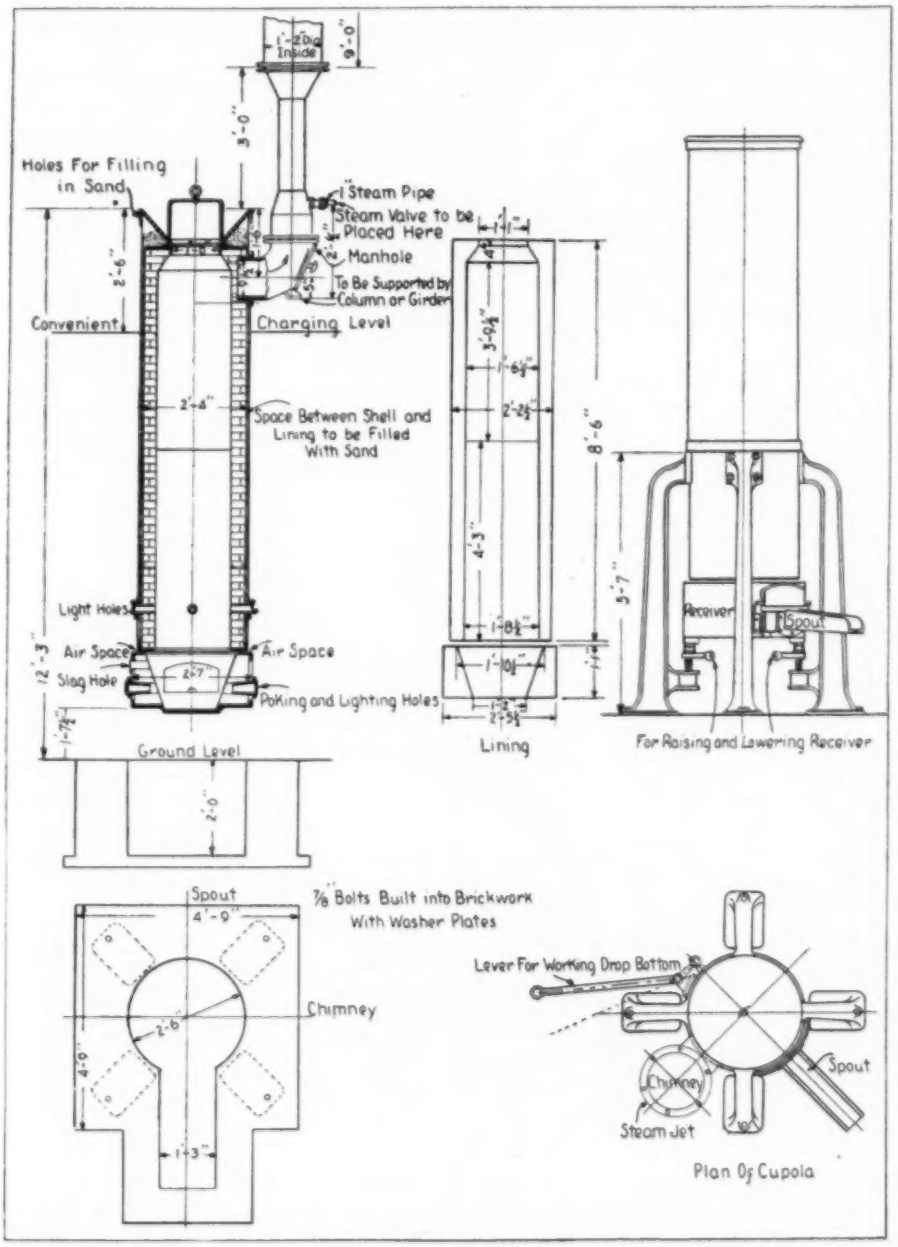


FIG. 9—A STEAM JET SUPPLIED WITH STEAM AT ABOUT 80 POUNDS PRESSURE ACTED AS AN INJECTOR IN THE CONSTRICTED PASSAGE

Probably the earliest method of taking care of varying quantities of metal for different requirements was that in which several single tuyeres were arranged vertically above one another on two opposite sides of the early rectangular cupolas. The first tuyere was located approximately 12 to 18 inches above the hearth and the remaining two or three tuyeres were separated by a vertical distance of from 3 to 6 inches. Tuyere nozzles flexibly connected to the blast supply by leather hose usually were connected to the lower level of tuyere openings while the upper openings were stopped with clay. When a larger amount of metal was required, the tuyeres were inserted at the higher levels and the lower openings were stopped in a like manner.

Form, construction and arrangement of tuyeres which have been used and adopted at one time or another is legion. Typical examples of the many forms are sufficiently illustrated in Fig. 8 and are taken from Kirk's book maintaining the same nomenclature. Kirk is able to trace the origin of the center-blast tuyere arrangement as far back as 1840 and

(*Concluded on Page* 759)

Apply Sand Control Methods-II

A Suitable Standard for Each Requirement May Be Determined for Each Class of Castings from the A. F. A. Standard Sand Tests

By W. G. Reichert

NATURAL sands submitted for trial are subjected to the following tests to determine their suitability: Tensile strength; permeability; grade; dry strength; durability; relative fusion; microscopic examination.

To provide a uniform product, it is advisable to test each carload of sand. If large variations are found, it is difficult to properly control the sand heaps, and this is especially true in a mechanical system where the sand is added systematically. The moisture content of green sand usually is much greater as received than when it is used in practice. To properly test the sand, it should be dried at 105 to 110 degrees Cent. for one hour, then retempered to the workable moisture content or spread out to air dry to this moisture content.

For routine checking of sand shipments the following physical properties are determined on each carload lot: Tensile strength, permeability, grade.

After obtaining a suitable sand it is essential to keep the heaps within predetermined limits, thereby giving the molder a uniform sand. In floor molding these tests need only be made once per day, but with a mechanical handling system they should be made several times during the day at definite intervals.

Controlling the Sand Heap

The tests used more than any others for controlling the heap and facing sand are as follows: Tensile strength test, permeability test, moisture test.

It is of interest to note that it is possible to determine these three tests in not more than 8 minutes, also that both tensile strength and permeability tests are determined on the same specimen.

Contamination of the heaps by core sand drippings, etc., are indicated by the following tests determined semi-monthly: Dry sand strength, grade test.

Table VI indicates testing limits which have been found to give good results when used in our light castings foundry.

Effect of mulling in a standard type muller and passing through a centrifugal aerator is illustrated in the chart Fig. 3. The moisture content on these sands follow: *A*—6.6 per cent; *B*—6.3 per cent; *C*—7.2 per cent.

In foundry practice usually it is not practical to mull the sand for any great length of time, so that in the charts mulling was indicated only for a 15-minute period.

Mulling tends to bring out the latent strength value of the sand to a marked extent, depending upon the time mulled and the clay content. There was no apparent effect on the

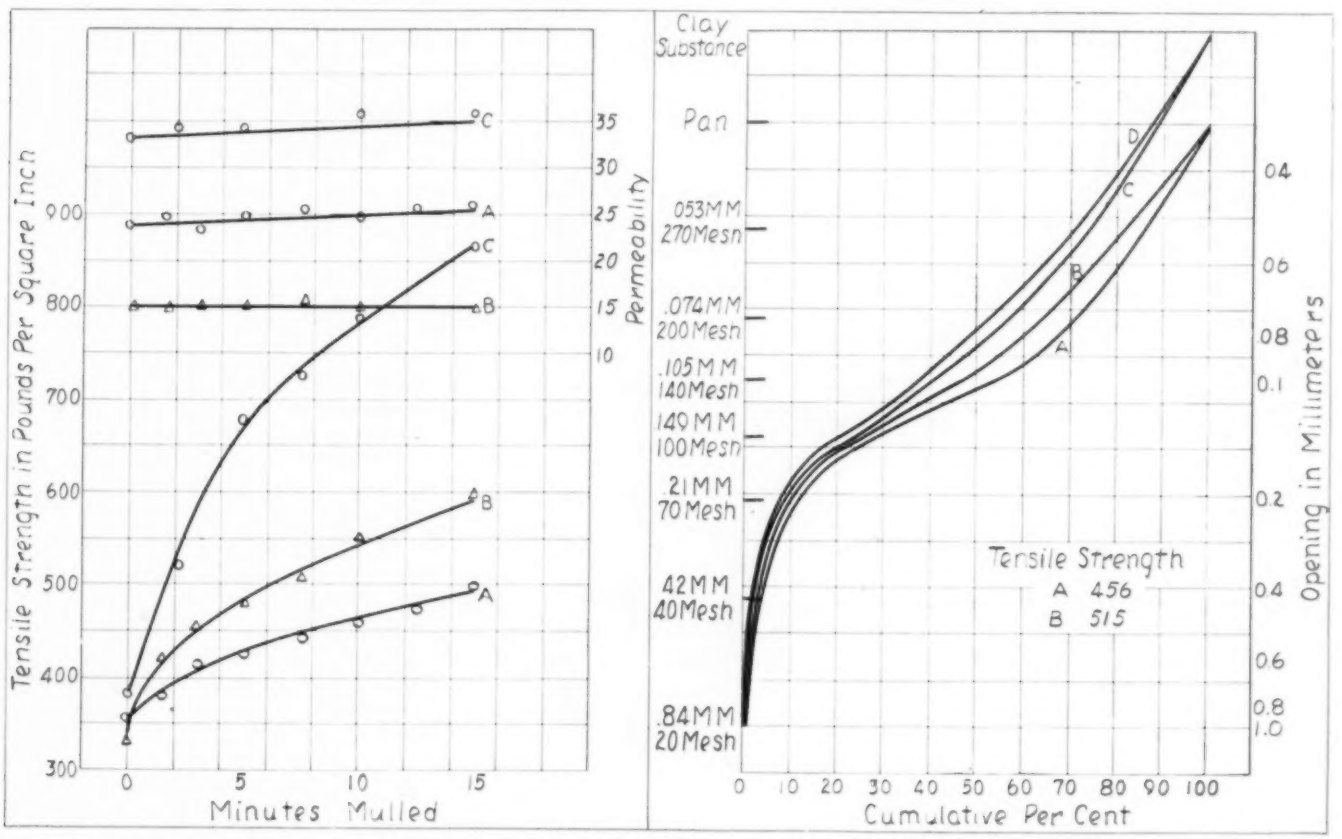
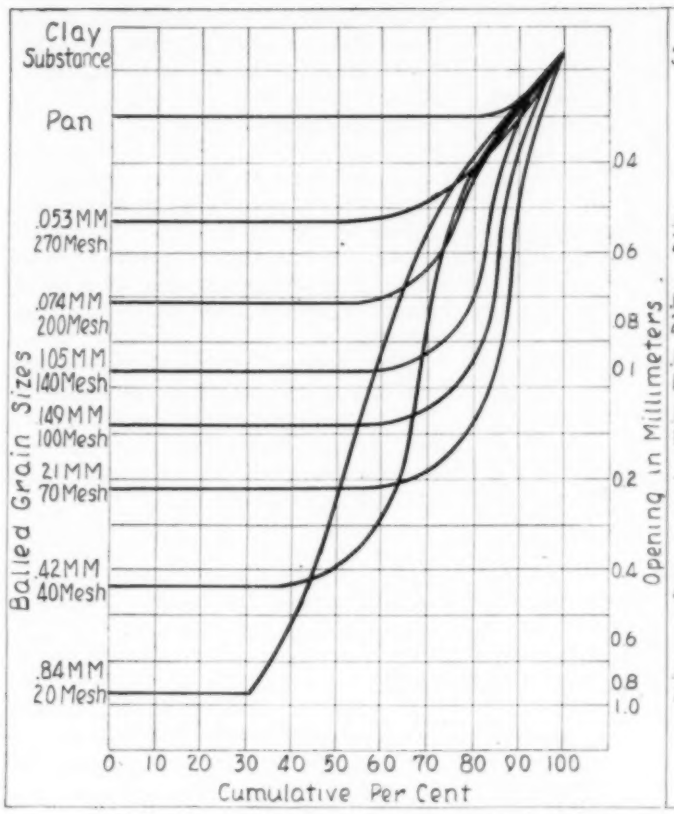


FIG. 3.—EFFECT OF MULLING AND AERATION ON THE TENSILE STRENGTH AND PERMEABILITY OF MOLDING SANDS *A*, HEAP SAND A.F.A. GRADE 2D; NATURAL SAND A.F.A., GRADE 1D; *C*, HEAP SAND A.F.A. GRADE 3E. FIG. 4.—EFFECT PRODUCED BY INCREASING THE WEIGHT OF THE ROLLS *A*, HEAP SAND MULLED 10 MINUTES, DRY TEST; *B*, HEAP SAND MULLED 10 MINUTES WITH 2-TON ROLLS, DRY TEST; *C*, GRADE TEST OF *A* DEFLOCCULATED; *D*, GRADE TEST OF *B* DEFLOCCULATED



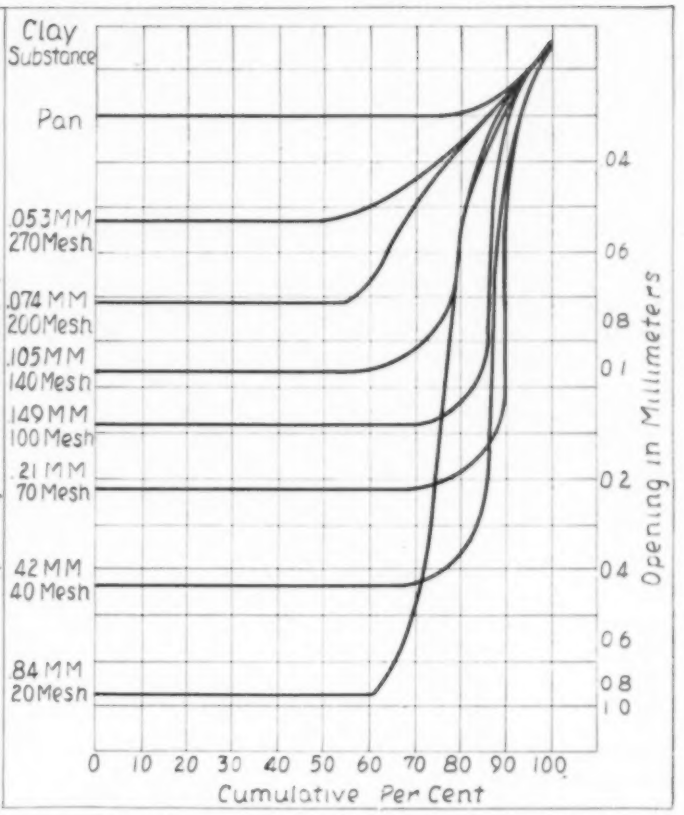


FIG. 5.—GRAIN SIZE COMPOSITION OF THE BALLED GRAINS IN FINE HEAP SAND. FIG. 6.—GRAIN SIZE COMPOSITION OF THE BALLED GRAINS IN FINE HEAP SAND AFTER MULLING 10 MINUTES

permeability or the grade test after passing through the aerator.

Results given led us to determine the effect of heavier rolls in mulling sands. Rolls weighing approximately 1 and 2 tons were compared under identical conditions for a 10-minute mulling period, and the results indicated in the chart, Fig. 4. The sand used in this test was passed through a centrifugal aerator and is that sand indicated as *A* in Fig. 3. The heavier rolls also had a 40 per cent larger face surface than the lighter rolls.

Heavier rolls give a better distribution of clay as indicated by an increase in strength and also have a greater tendency to break down the grain clusters.

The small difference in the deflocculated grade tests probably results from a slight breaking down of the sand grains due to the heavier rolls.

Examine Balling Action

Advantages obtained from a muller in a mechanical handling system may be grouped as follows: To uniformly distribute the green sand and the moisture in the shortest possible time; to obtain a good distribution of clay over the sand grains, depending upon the time mulled; to increase the tensile strength of the sand; to break down the clusters or balled sand particles which arise from mechanical handling.

Sand deteriorates considerably due to the coarsening of the sand from the balling of the fine grain particles and clay.

If the sand is dried and then sieved without deflocculating and washing away the clay a determination is ob-

Table VI

Testing Limits for Various Sections

Section	Sand	Moisture	Tensile Strength lb./in.²	Permeability
⅛-½	Facing	6.0-6.5	0.350-0.420	18.24
	Heap	6.5-7.0	0.290-0.350	19-26
½-1	Facing	6.5-7.0	0.660-0.770	30-40
	Heap	6.8-7.3	0.420-0.490	34-44
Green Core Sand		7.2-7.8	1.150-1.400	55-75

Table VII

Size Balled Grains in Fine Heap Sand

Mesh	20 Mesh	40 Mesh	70 Mesh	100 Mesh	140 Mesh	200 Mesh	270 Mesh	Pan
6	.....	.....	.....	.....	.....	.....	.....	.....
12	.....	.....	.....	.....	.....	.....	.....	.....
20	30.8	.....	.....	.....	.....	.....	.....	.....
40	13.8	36.9	.....	.....	.....	.....	.....	.....
70	5.6	26.5	44.0	.....	.....	.....	.....	.....
100	3.4	2.3	36.0	52.7	.....	.....	.....	.....
140	6.0	2.9	4.5	26.9	50.9	.....	.....	.....
200	7.4	3.4	2.5	5.0	29.6	56.8	.....	.....
270	3.0	1.9	2.5	1.5	3.1	18.1	47.9	.....
Pan	16.0	11.7	4.5	6.2	5.7	13.9	42.6	80.6
Clay Substance	14.0	14.4	6.0	7.7	10.7	11.2	9.5	19.4

Table VIII

Heap Sand Milled for 10 Minutes

Mesh	20 Mesh	40 Mesh	70 Mesh	100 Mesh	140 Mesh	200 Mesh	270 Mesh	Pan
6	.....	.....	.....	.....	.....	.....	.....	.....
12	.....	.....	.....	.....	.....	.....	.....	.....
20	61.8	.....	.....	.....	.....	.....	.....	.....
40	10.0	68.9	.....	.....	.....	.....	.....	.....
70	1.6	17.3	66.6	.....	.....	.....	.....	.....
100	2.2	0.8	23.2	67.3	.....	.....	.....	.....
140	2.1	0.5	0.4	19.5	51.1	.....	.....	.....
200	2.3	0.9	0.3	1.3	28.2	56.2	.....	.....
270	1.3	0.4	0.2	0.3	2.3	11.6	46.9	.....
Pan	8.7	4.3	1.7	2.2	6.3	18.6	38.9	78.9
Clay Substance	10.0	6.9	7.6	9.4	12.1	13.6	14.2	21.1

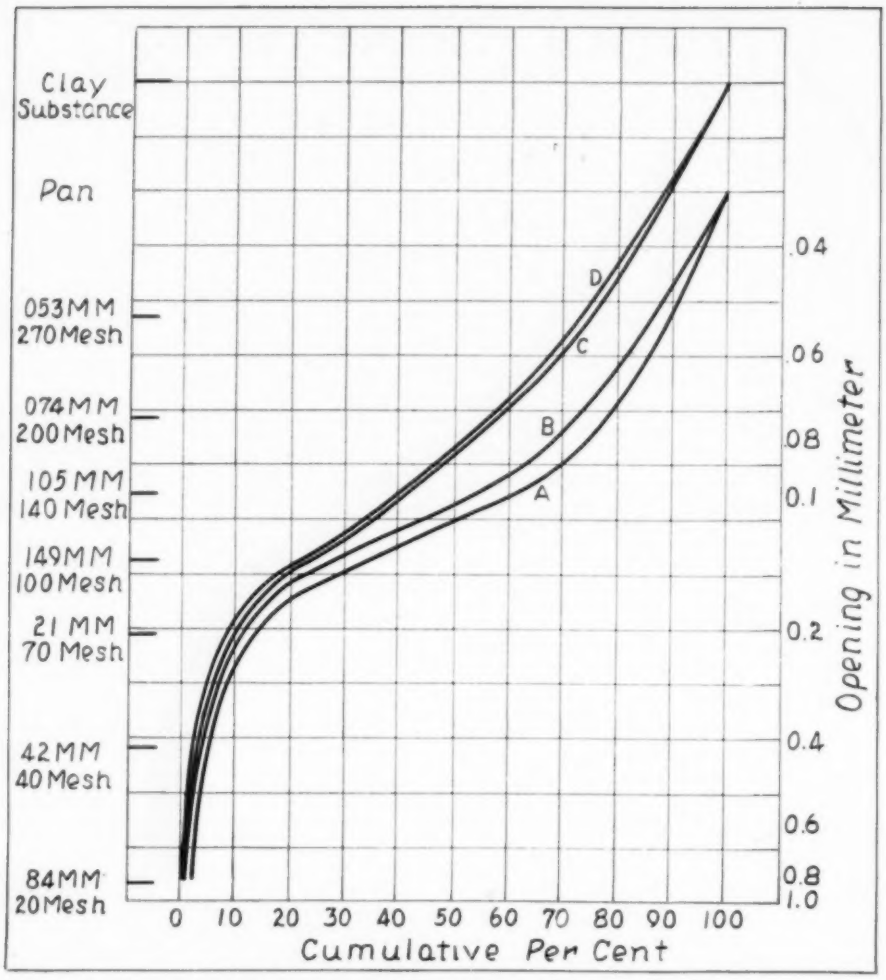


FIG. 7.—GRAIN SIZE OF BALLED SAND IN THE NATURAL AND DEFLOCCULATED CONDITIONS *A*, HEAP SAND, DRY TEST; *B*, HEAP SAND MULLED 10 MINUTES, DRY TEST; *C*, GRADE TEST OF *A* DEFLOCCULATED; *D*, GRADE TEST OF *B* DEFLOCCULATED

tained to show how badly the clay is balled. Figs. 5 and 6 illustrate the grain composition of the balled grains in a fine heap sand. Tables 7 and 8 give the tabulated results of this test. In preparing a sample for test, the sand was dried at 105 to 110 degrees Cent. for one hour and sieved according to the tentatively adopted methods of test of the committee on molding sand research, as reported in A.F.A. *Transactions*, Vol. 31, page 722. The sand was removed, more added and the operation repeated until a sufficient quantity was obtained for a deflocculated grade test of the material retained on each sieve.

A comparison of the grain size of balled sand in the natural and deflocculated condition, also the same sand after mulling for 10 minutes in a muller whose rolls weighed 1 ton and aerated is illustrated in the chart Fig. 7.

There is practically no breaking down of the sand grains. The balling action of a sand may be described as the formation of hard rounded pellets of fine sand and clay. These pellets naturally increase the essential grain size of the sand and the effect is proportional to the amount of sand and clay in the mixture that has been balled.

FIG. 8.—MOISTURE IS CONTROLLED THROUGH A WATER METER

Sand which is moistened and remains for at least several hours before cutting over, allowing the moisture to distribute uniformly, as in floor molding, will ball up slowly. In floor molding the sand is moistened after the floor is shaken out and remains this way for a number of hours before it is used. It is generally known that sand becomes coarser through handling, and this effect is of much greater magnitude with mechanical handling.

Balling effect of sand is due to the movement of the sand containing a critical moisture content together with an uneven distribution of moisture. The balling effect is increased by an excess clay content.

A badly balled sand always is a source of trouble in the foundry, but may be counteracted by the addition of a fine sand, a lower clay content sand, mulling, improvement in handling conditions, or a combination of these.

Moisture Control

In foundries making heavy castings the moisture content may vary considerably, but it plays an important part in our particular case affecting both the discount and surface quality of our small castings and we must aim to keep it as uniform as possible. Examination of daily moisture records showed quite a variation and means were devised to reduce this as far as possible.

A water meter attached to the muller has been tried over a long period and has given good results. By the use of this meter together with constant checking by the laboratory, moisture tester, previously described, a uniform facing sand is obtained which has considerably reduced our moisture variation.

At first we attempted to conserve the refuse sand from the rattlers which consisted of approximately 4 per cent iron dust by converting this iron dust into ferric oxide by an ageing process. The sand later was made into a substitute for natural sand by mulling with the proper addition of clay. After a long period of use the surface quality of the castings began to deteriorate. The fusion point was lowered due to the gradual accumulation of iron oxide, and for this reason use of this reclaimed sand was discontinued.

Later we successfully reclaimed the burnt sand which clings to the sprues and gates of the casting and which is not contaminated with iron. We use essentially two grades of sand and the burnt sand is mixed. To obtain sands which are satisfactory for our purpose it is necessary to make

a separation into two grades, a coarse grade for medium light sections, and a fine grade for light sections. The sand is separated by a vibrating screen arranged to give the desired products. The material retained on the upper screen, consisting of small iron particles and large burnt sand clusters, is discarded. The material retained on the lower section, A. F. A. grade No. 3, is used for medium light sections where permeability is required. Material passing through the second section, A. F. A. grade No. 1, is used for very light castings. Water is sprinkled into enclosed receiving bins so that no dust is created when the material passes through screens.

Each grade of sand is mulled from 5 to 8 minutes with a definite amount of clay, the mulling is continued only long enough to get a good distribution. The sand is passed through a centrifugal aerating machine and then is ready for use. A dry pulverized clay ground to 140 mesh is used for this purpose. This sand is a satisfactory substitute for natural sand, and can be used alone or mixed with other sands.

Special attention should be given to the quantity of clay and its distribution. Many failures may be attributed to a faulty clay content. For best results the clay content should be kept as low as possible consistent with green strength values of the molding sand.

A synthetic sand is used for making green sand cores where strong sand with a relatively high permeability is essential. Sea sand, burnt core sand, and clay are used. The mixture is mulled and aerated in the manner previously described.

Completes Large Gray Iron Foundry

THE Chicago Pneumatic Tool Co., New York, recently has completed a large modern foundry at Franklin, Pa., where all gray iron castings for compressors and engines will be made. The buildings and equipment represent an investment of over $400,000. The equipment is modern throughout and consists in part of two cupolas, one with a capacity of 16 tons per hour and one with a capacity of 8 tons per hour; two rotary blowers; five traveling cranes, three of 15 tons capacity, one of 10 tons capacity and one of 5 tons capacity; several molding machines of various capacities from 1000 pounds to 20,000 pounds; four squeeze molding machines; three hopper type automatic sand handling units; mold drying ovens; yard cranes; two large and four small core ovens and miscellaneous equipment.

A daily capacity of 30 tons of castings is provided with ample provision for doubling this tonnage. The foundry building is 130 feet wide x 220 feet long and a storage shed also has been erected which is 60 feet wide x 330 feet long. This new foundry is adjacent to the main plant which consists of power plant, machine shop, erecting floors, pattern shop, offices and shipping platforms. The company also has large plants at Detroit and Cleveland.

The Prest-O-Lite Co. Inc., recently added two new plants to its nation-wide chain making the total 33. These will serve nearby industry with acetylene. A plant in charge of H. A. Smith, 631 South Seventeenth street, Harrisburg, Pa., started production on July 12, and another at Seventeenth and W. Lawrence streets, Allentown, Pa. J. W. Summers, superintendent, commenced operations on July 21.

INTERIOR OF NEW GRAY IRON FOUNDRY BUILT BY THE CHICAGO PNEUMATIC TOOL CO., AT FRANKLIN, PA.

QUERIES ON FOUNDRY PRACTICE

Suggested Solutions for Common and Unique Shop Problems

Casting Copper Vanes in Gray Iron

QUERY

I have an order for a small gray iron cylinder 4 x 12 inches in which the customer wants a number of copper vanes. In the rough the wall thickness of the casting is only ⅜-inch. What gage copper plate shall I use? Is it necessary to tin the part which enters the iron? How shall I gate the casting to avoid melting the copper?

ANSWER

You are flirting with a dangerous and tricky job and one which probably will yield you more grief than than thanks. If you had an order for a large number of castings at a price that would permit you to do considerable experimenting, you probably could develop a method for making the casting satisfactorily, but otherwise the outlook is not so bright. You need not be afraid of the copper melting. On the contrary your greatest danger lies in the fact that the vanes may not *knit* firmly to the iron and either will work loose or cause the cylinder to leak after it has been bored out. Tinning the surface is optional, but the vanes must be perfectly dry and clean and it is advisable to sink a narrow groove along both sides close to the edge to give the iron a *grip*.

Casting Scabbed on Top

QUERY

I am forwarding for your inspection the top part of an insulator cap on which you will note a small cut or scab on the outside. I shall appreciate your opinion on the probable cause of this defect so that I may take the proper steps for its prevention.

ANSWER

Since the remainder of the surface of the casting is quite clean it is apparent that the trouble is due to some local condition. The cut or scab is caused by a boiling action of the metal at that point, but the exact cause of the boiling only can be discovered by a process of elimination. Our first guess is that the gas is not getting away properly from the main or center core. This will cause a boiling action in the thin upright wall which will culminate at the top and chew some of the sand out of the cope. The same effect will be produced if the upright outside green sand wall of the mold is too hard, or too damp or if the sand is too tight. The second probable cause is that the sand is damp or tight or rammed too hard in the cope. This theory is strengthened by the fact that the socket core is suspended in the cope and the molder wants to have his sand nice and stiff to hold it in place. If this is the case two remedies are available. One is to use a coarser grade of sand. The other is to vent the cope with a wire. The rough surface on the casting is caused by boiling iron, but the exact cause of the boiling action will have to be determined by checking the progress in the making and pouring of several molds.

Metal for Mold Boards

QUERY

I should like to have the mixtures for pouring two kinds of mold boards for plows, one to show a chill of $\frac{3}{16}$ to ¼-inch, the other a chill of ⅜ to ½-inch. These mold boards are cast on a chill for a drag and with a green sand cope.

ANSWER

The actual mixture, that is the number of pounds of each kind of iron entering the charge will depend on the variety of iron you have in the stock yard. The tendency of iron to *chill* depends principally on the silicon content and this element can be controlled through an almost indefinite range by the addition of steel scrap or low silicon pig iron or scrap. Through some inherent quality charcoal iron seems to give better results than coke iron in chilled castings and for that reason many agricultural implement makers add from 15 to 25 per cent charcoal iron to their mold board mixtures. Others secure satisfactory castings without its aid. Iron for mold board castings will conform to the following approximate analysis: Silicon 1.00 to 1.25 per cent, sulphur 0.10 per cent, manganese 0.75 to 1.00 per cent, phosphorus 0.25 to 0.40 per cent. Within these ranges you will have to determine by actual experiment the composition of the charges to give the desired depth of chill. You can set up a few sand molds on a thick iron plate or block and not the effect of the chill on a small portion of iron poured from a hand ladle.

Methods Used in Molding Cast Iron Balls

QUERY:

We have a standing order for 60,000 pounds per month 1¼-inch diameter cast-iron balls and we are anxious to adopt a more satisfactory molding method than the one we now employ. At present we have 80 split patterns mounted on a matchplate, half of each pattern on the cope side and half on the drag side. The iron is poured through a single long runner in the center with small connecting gates between adjoining molds. The molds are made in a 14 x 18-inch snap flask and are rammed on a small combination jolt-squeeze machine. Our loss from shifted and dirty castings is too high and we shall appreciate your opinion on whether it is feasible to make these castings in some form of permanent iron mold.

ANSWER:

The method you now employ is the one practically in universal use in all foundries, both gray iron and malleable where small cast iron balls are made in considerable quantities. In your case 60,000 pounds per month means about 2300 pounds per day. Each ball weighs ¼-pound which means a total of 9200 individual castings per day. With 80 castings in a flask you will require 115 good molds per day to meet your schedule. The trouble with your present equipment is that your patterns are too close together and your flask is too small. With a reasonable sand wall between the individual molds you would have no trouble either from shifted or dirty castings. The remedy of course is to provide a larger flask in which the 80 patterns may be separated from each other by a wider margin, or, to use your present flask with a smaller number of patterns and put up a corresponding number of extra molds.

Permanent molds are used for making cast-iron balls and the methods have been described in THE FOUNDRY. We doubt if the idea is practicable under ordinary circumstances where the foundry heat is poured off in one or two hours. If the heat extended from one end of the day to the other the required number of balls might be made with only a few molds, but the number would have to be increased greatly to produce 9000 or 10,000 castings in a limited time in the afternoon. Usually iron molds are used for large sizes.

Physical Tests of Cast Iron *Give Interesting Data*

Part-II

By J. B. Kommers

A SUMMARY of the tension, compression, hardness, transverse, impact and fatigue tests is given in Table III. The individual results have been shown for the tension, compression, hardness, transverse and impact tests, so that an idea of the uniformity of the material may be obtained.

For series *A* the impact result marked with a superior *a* was not included in determining the average. This specimen did not break at the center of the span as did the other bars and undoubtedly is not representative of the material.

Figs. 22, 23 and 26 show the *S-N* diagrams for the various cast irons as determined from the fatigue tests. In these diagrams the value of unit stress, *S*, to which the specimen was subjected is plotted as the ordinate, and the value of number of cycles for rupture, *N*, is plotted to logarithmic scale as the abscissa. Figs. 24, 25 and 27 show the correlation between endurance limit and the various results obtained from the other tests. Figs. 28, 29, 30 and 31 show the correlation between the various test results, not including the fatigue tests. What seemed to be the more important relations between the various results have been plotted.

In general the results of the hardness, compression and transverse tests are fairly uniform for any given series, and this would indicate that the material was fairly uniform. This is not true of the tensile, impact and fatigue results. These latter three tests seem to be much more sensitive to differences in specimens, and presumably are much more sensitive in picking out flaws and weaknesses if they exist.

It will be noted that in general the *S-N* diagrams for the fatigue results show considerable scatter, much more than is encountered with uniform ferrous or nonferrous materials. This would indicate that cast iron in general is not as homogeneous as some of these other materials. Such a conclusion would of course be expected.

Summarizes His Work

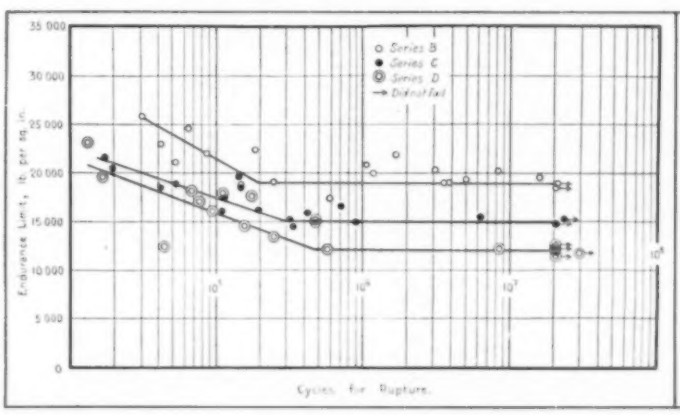
IN THIS second and concluding article the author discusses the results obtained on the basis of uniformity of materials, high strength cast iron, effect of nickel and chromium, hardness tests and correlates the various tests. He also suggests some further investigations that should be carried out to increase the data on physical properties of cast iron.

The *S-N* diagram for series *E* is probably the most uniform of all the cast irons tested. A glance at Table III will show that this uniformity also is indicated by the results on this series recorded in the table. Series *A*, which shows considerable scatter on the *S-N* diagram for the fatigue results, also shows considerable variation for the tensile and impact results. Series *B*, which is somewhat more uniform than series *A* on the *S-N* diagram, also shows better uniformity than series *A* for the tensile results but not for the impact.

Series *F* and *G* which show considerable variation on the *S-N* diagrams, also show considerable variation for the impact results, but are quite uniform for the tensile results. Series *C* and *D*, which are fairly uniform on the *S-N* diagrams, are also quite uniform for the tensile and impact values. Series *H*, which shows more scatter on the *S-N* diagram than does series *K*, also shows somewhat more variation in the tensile results. Series *J* shows some scatter on the *S-N* diagram, and also some variation for the impact results.

In general the conclusion may be drawn from these results that the tensile, impact and fatigue tests are more sensitive to differences in material than the hardness, compression and transverse tests.

A characteristic result which shows non-uniformity of material was indicated by a number of the irons, for instance series *F*, *G*, *H*, *J* and *K*. On the *S-N* diagram for all of these will be found plotted points near the left edge of the diagram, lying lower than the average curve. This indicates that quite a number of specimens did not show the endurance for a given unit stress which might be expected from a normal sample. Such abnormality was strikingly brought out by three specimens of series *J* which showed numerous small pits over the entire surface even after they were polished. These specimens when tested all showed abnormally low en-



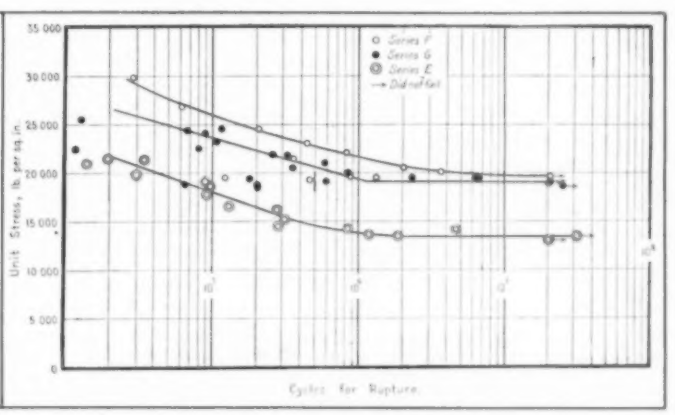


FIG. 22—*S-N* DIAGRAM FOR SERIES B, C, AND D. FIG. 23—*S-N* DIAGRAM FOR SERIES F, G AND E

durance for a given unit stress. These specimens were so obviously abnormal that the results were not plotted on the *S-N* diagram.

Series *H* and *K* were supposed to be alike except for the addition of 1.15 per cent of nickel to series *H*. These two irons are considerably stronger than any of the others and may be spoken of as high-strength cast irons. The endurance limits found for these two cast irons are the highest values for cast iron thus far reported, as far as the author is aware. The highest value previously

Table III

Summary of Results of Tests

	Tensile strength		Compression test		Hardness test			Transverse test			Impact	Fatigue
	Small specimen, lb. per sq. in.	Large specimen, lb. per sq. in.	Unit stress at first bend, lb. per sq. in.	Unit stress at ultimate, lb. per sq. in.	Brinell number	Rockwell Number, "B" Scale: At center	Rockwell Number, "B" Scale: At mid-radius	Maximum Load, lb.	Maximum deflection, in.	Modulus of rupture, lb. per sq. in.	Energy of rupture, in-lb. per cu. in.	Endurance limit, lb. per sq. in.
Series A.	34,900	28,300	77,200	109,200	197.0	90.0	95.0	5,030	0.162	78,700	77.3*	
	34,600	39,300	76,200	107,900	201.0	87.5	93.0	4,630	0.129	72,700	44.2	
	37,500	37,600	70,000	109,800	203.0	89.0	94.0	4,750	0.159	74,100	38.9	
	.....	.....	.....	.....	203.0	85.0	93.0	4,730	0.156	74,600	34.4	
	.....	.....	.....	.....	207.0	90.0	93.0	4,430	0.140	69,200	31.0	
Average	35,700	35,100	74,500	109,000	202.0	88.3	93.6	4,714	0.149	73,900	37.1	19,000
Series B.	38,700	42,000	73,600	138,700	207.0	96.5	98.3	4,280	0.118	67,000	22.5	
	40,000	39,600	78,100	138,000	207.0	98.0	99.0	4,110	0.112	64,300	16.4	
	39,800	37,400	81,500	136,100	212.0	95.8	98.0	4,040	0.111	63,300	19.8	
	.....	.....	.....	.....	201.0	93.0	98.0	4,200	0.111	65,800	19.2	
	.....	.....	.....	.....	209.5	98.5	99.0	4,220	0.115	66,300	27.8	
Average	39,500	39,700	77,700	137,600	207.3	96.3	98.5	4,170	0.113	65,300	21.1	19,000
Series C.	27,500	31,400	81,200	117,800	197.0	90.5	97.5	3,880	0.124	60,800	17.2	
	32,700	32,600	75,700	114,500	192.0	90.0	98.0	3,560	0.097	55,800	17.0	
	30,800	33,000	80,400	120,400	197.0	88.5	96.0	3,720	0.111	58,400	17.0	
	.....	.....	.....	.....	189.5	87.5	96.0	3,720	0.113	58,300	22.5	
	.....	.....	.....	.....	192.0	92.0	95.0	3,640	0.112	56,800	17.5	
Average	30,300	32,300	79,100	117,600	193.5	89.7	96.5	3,704	0.111	58,000	18.2	15,000
Series D.	33,100	31,700	83,300	123,800	194.5	93.0	94.0	4,030	0.127	63,200	23.6	
	33,000	28,800	83,100	121,600	192.0	88.0	96.0	3,740	0.100	56,200	22.9	
	29,600	30,600	81,500	123,000	192.0	93.0	97.0	3,580	0.120	58,300	21.6	
	.....	.....	.....	.....	187.0	88.0	97.0	3,800	0.111	59,300	21.6	
	.....	.....	.....	.....	197.0	84.0	96.0	3,960	0.125	62,000	18.6	
Average	31,900	30,400	82,600	122,800	192.5	89.2	96.0	3,822	0.117	59,800	21.7	12,000
Series E.	32,500	30,600	77,700	116,900	185.8	91.5	97.0	3,520	0.122	55,300	24.4	
	32,100	31,500	85,600	118,800	187.0	94.5	96.0	3,760	0.126	58,700	23.3	
	31,200	31,100	74,300	115,400	179.0	93.5	96.0	3,960	0.140	62,300	26.5	
	.....	.....	.....	.....	183.0	96.0	96.0	4,000	0.145	62,700	20.6	
	.....	.....	.....	.....	187.0	92.5	95.0	3,900	0.138	61,300	22.2	
Average	31,900	31,100	79,200	117,000	184.4	93.6	96.0	3,830	0.134	60,100	23.4	13,400
Series F.	38,600	35,700	82,700	133,200	209.5	95.5	97.5	4,600	0.153	72,500	30.6	
	35,400	36,400	82,800	129,100	214.5	97.5	97.5	4,260	0.133	66,800	25.1	
	37,200	34,600	80,900	133,700	209.5	95.0	97.5	4,670	0.148	73,500	27.8	
	.....	.....	.....	.....	207.0	97.0	98.0	4,080	0.121	64,000	17.3	
	.....	.....	.....	.....	207.0	94.0	97.5	4,120	0.112	64,400	23.8	
Average	37,100	35,600	82,100	132,000	209.5	95.8	97.6	4,346	0.133	68,200	24.9	19,500
Series G.	36,700	33,400	76,300	128,700	194.5	88.0	93.0	4,360	0.140	68,600	18.4	
	37,300	33,000	77,500	135,900	198.5	95.0	96.5	4,660	0.171	73,200	30.7	
	32,900	34,800	78,800	128,200	197.0	92.0	96.5	3,760	0.111	59,000	34.9	
	.....	.....	.....	.....	197.0	96.0	96.0	4,620	0.168	72,300	23.6	
	.....	.....	.....	.....	201.0	93.0	96.0	4,490	0.168	70,200	26.4	
Average	35,600	33,700	77,500	130,900	197.6	92.8	95.6	4,378	0.152	68,700	26.8	19,100
Series H.	55,500	51,500	83,300	158,500	241.0	100.5	101.0	5,720	0.180	89,800	45.1	
	43,200	48,400	83,600	145,000	248.0	100.0	100.0	5,460	0.162	85,500	41.6	
	54,200	44,300	81,100	165,300	235.0	99.0	101.0	5,530	0.185	86,800	48.1	
	.....	.....	.....	.....	237.0	100.0	100.0	5,660	0.190	88,700	43.6	
	.....	.....	.....	.....	233.0	102.0	101.0	5,770	0.189	90,400	41.5	
Average	51,000	48,100	82,700	156,300	238.8	100.3	100.6	5,628	0.181	88,200	44.0	22,000
Series J.	23,600	23,600	74,000	86,000	179.0	86.5	88.0	3,260	0.113	51,100	15.9	
	26,000	24,700	73,000	85,000	174.0	87.0	89.0	3,690	0.141	57,700	16.7	
	20,000	26,500	74,000	84,000	179.0	90.0	88.5	3,520	0.127	55,100	20.0	
	.....	.....	.....	.....	174.0	86.5	89.5	3,200	0.102	50,100	17.7	
	.....	.....	.....	.....	152.0	84.0	85.5	3,580	0.134	56,100	12.4	
Average	23,200	24,900	73,700	85,000	171.6	86.8	88.1	3,450	0.123	54,000	16.5	11,800
Series K.	41,900	47,600	79,200	152,800	241.0	92.5	99.0	4,830	0.132	75,500	36.0	
	40,700	52,300	75,600	152,600	229.0	95.5	99.0	5,390	0.125	84,300	28.6	
	45,100	51,000	82,000	158,800	235.0	96.5	98.5	4,840	0.121	76,000	.....	
	.....	.....	.....	.....	244.5	98.5	99.0	4,340	0.100	67,400	.....	
	.....	.....	.....	.....	235.0	97.5	98.5	4,780	0.119	74,800	.....	
Average	42,500	50,300	78,900	154,700	236.9	96.1	98.8	4,836	0.119	75,600	32.3	24,100

*Not included in determining the average.

NOTE—The loads in the transverse test have been reduced to a common diameter of 1.25 inch.

reported was found by C. H. Bulleid, Engineering (London) Oct. 1, 1926, and was 21,700 pounds per square inch. The fact that series *J*, which gave the lowest value of the present series, had an endurance limit of 18,800 pounds per square inch and that series *K* gave a value of 24,100 pounds per square inch, indicates that cast iron need not be looked upon as a uniformly low-strength material. The strength of cast iron evidently can be controlled in a manner similar at least to that in the case of steel.

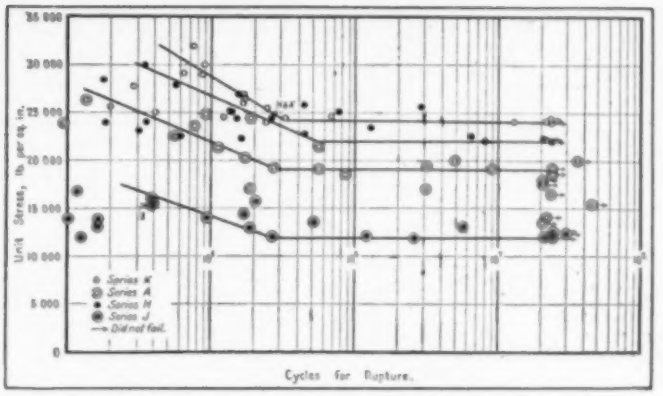


Fig. 26—S-N Diagram for Series K, A, H, and J. The Unit Stress Is the Ordinate and the Cycles for Rupture Are the Abcissa on a Logarithmic Scale

Series *F* and *G* were the same in composition except that series *F* had received an addition in the ladle of 0.66 per cent of nickel and 0.25 per cent of chromium. Table III shows that the addition of these alloys had a slight strengthening effect. As previously stated, series *H* and *K* were supposed to be the same in composition except that series *H* had added to it 1.15 per cent of nickel. Most of the values in Table III are higher for series *H* except the endurance limit, which is higher for series *K*. Series *H* shows a considerable advantage in the modulus of rupture and energy of rupture.

While the above results, especially series *F* and *G*, show no outstanding advantage for the alloy irons, it must be remembered that the tests here used may not be such as to bring out the advantages of the use of alloys. One important use of alloys is to produce uniform hardness in castings which vary in thickness, and the present tests are not such as will throw light on this question.

It may be worth noting that on the Rockwell scale the softest iron gave a result of 88.1 and the hardest a result of 100.6, a difference of 12.5 points. The brinell test gave a value of 171.6 for the softest iron and 238.8 for the hardest, a difference of 67.2 points. It may be concluded from these results that the brinell scale of hardness would be more likely to point out slight differences in hardness than the Rockwell scale.

Correlates Various Results

With the results of ten different cast irons available, it seemed desirable to determine whether any correlation existed between endurance limit and the results from the other tests. Figs. 24, 25 and 27 show these relations.

In Fig. 24 the endurance limit has been plotted as the ordinate and the tensile strength and Rockwell hard-

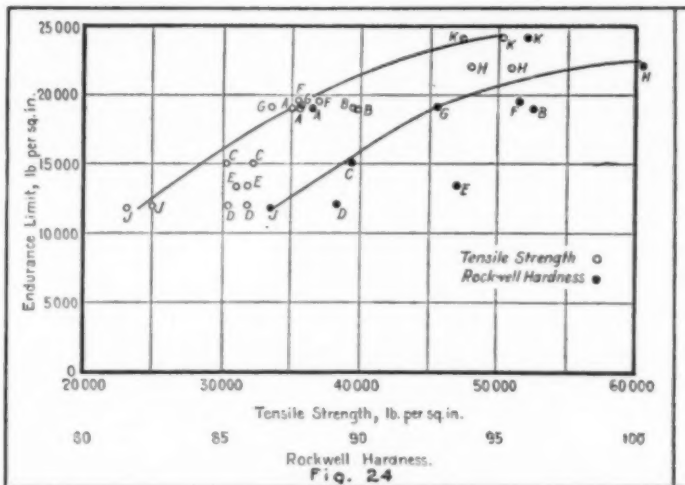


Fig. 24

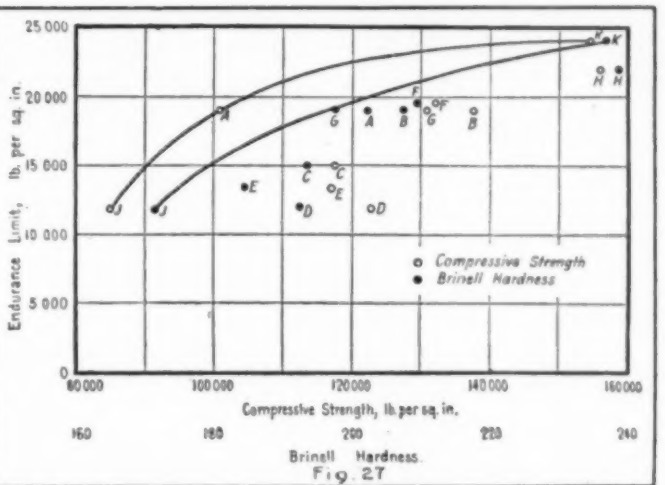


Fig. 27

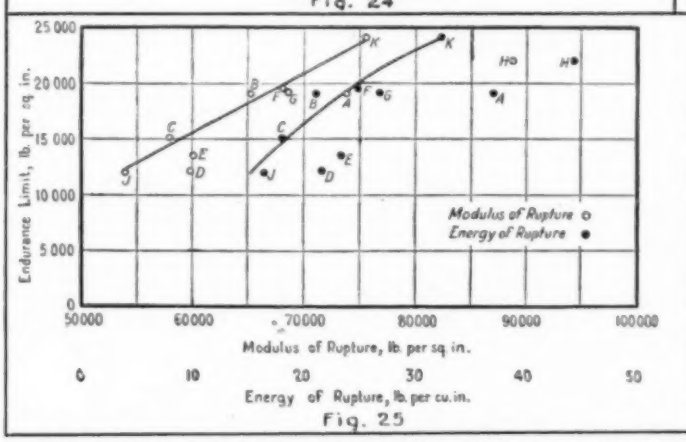

Endurance Limit, lb. per sq. in.
Modulus of Rupture, lb. per sq. in.
Energy of Rupture, lb. per cu. in.
Modulus of Rupture
Energy of Rupture

Fig. 25

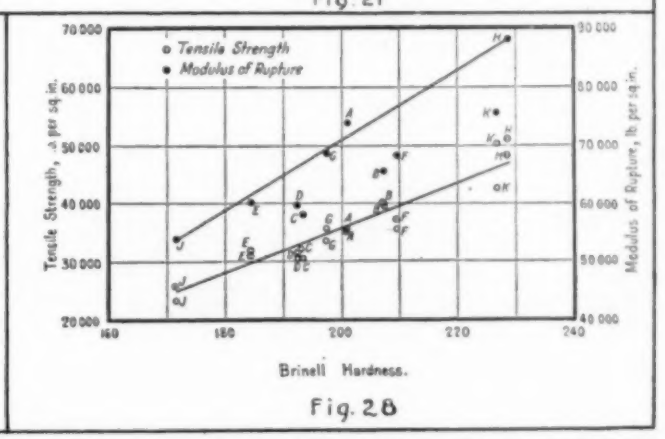


Fig. 28

FIG. 24—RELATION BETWEEN ENDURANCE LIMIT AND TENSILE STRENGTH, AND ENDURANCE LIMIT AND ROCKWELL HARDNESS. FIG. 25—RELATION BETWEEN ENDURANCE LIMIT AND MODULUS OF RUPTURE, AND ENDURANCE LIMIT AND ENERGY OF RUPTURE. FIG. 27—RELATION BETWEEN ENDURANCE LIMIT AND COMPRESSIVE STRENGTH, AND ENDURANCE LIMIT AND BRINELL HARDNESS. FIG. 28—RELATION BETWEEN BRINELL HARDNESS AND TENSILE STRENGTH, AND BRINELL HARDNESS AND MODULUS OF RUPTURE

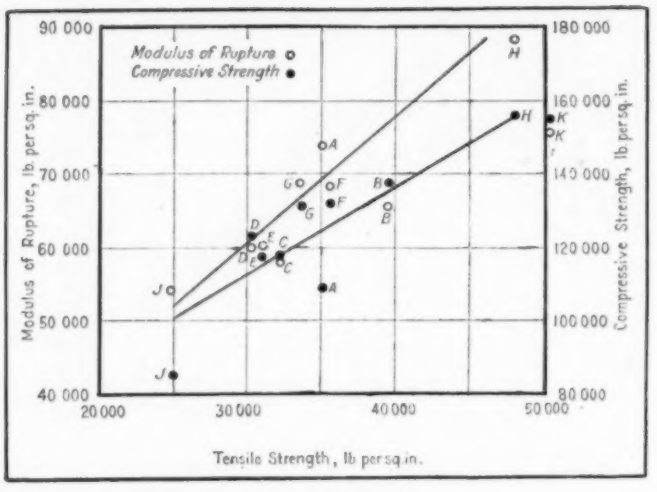


Fig. 29 — Relation Between Tensile Strength and Modulus Rupture, and Tensile Strength and Compressive Strength

ness as abscissa. The tensile results for both the small and large specimens were plotted, since Table III shows that there is little difference in these results. In Fig. 24 no attempt was made to draw average curves through the plotted points, but instead the curves were drawn through the points showing the highest values of endurance limit. This shows the general relation between the quantities and at the same time indicates which cast irons showed a particularly high endurance limit for given values of tensile strength or hardness. The various iron series may be identified by the letter placed next to each plotted point.

Curves show that the endurance limit increases with increase of tensile strength and hardness, but the endurance limit tends to approach an asymptotic value at the higher values of strength and hardness.

Fig. 25 shows the correlation between endurance limit and compressive strength and brinell hardness. The curves show the same general tendency as in Fig. 25. In both Figs. 24 and 25 it would be interesting to know why some of the irons show such low values of endurance limit considering their strength and hardness.

Fig. 27 shows the correlation between endurance limit and modulus of rupture, and also energy of rupture. If the upper ends of the curves had been drawn through the points *H* instead of *K* the curves would again show a marked falling off of endurance limit at high values of modulus of rupture and energy of rupture.

These results indicate that an approximate value of the endurance limit may be estimated from any of these curves. The simplest test would probably be to determine the brinell hardness and estimate the endurance limit from the endurance-limit-hardness curve. However, at the present time, the information of the effect of variable factors in influencing the properties of cast iron is so meager that such approximate determinations should always be checked by direct experiment.

In Table IV the correlation between endurance limit and the other test results has been indicated by computing for each series the ratio of the endurance limit to tensile strength, and in the same way the ratio of endurance limit to the other test results. It will be noted that the values of any given ratio are not constant but vary somewhat. The extent of this variation has been shown by calculating the average ratio, and then computing the mean variation from the average in per cent. These computations show that the best correlation is between endurance limit and tensile strength, compressive strength and modulus of rupture. For these three strength values the mean variation from the average for

Table IV

Correlation of Test Results

	Ratio, endurance limit to tensile strength	Ratio, endurance limit to compressive strength	Ratio, endurance limit to Rockwell hardness	Ratio, endurance limit to brinell hardness	Ratio, endurance limit to modulus of rupture	Ratio, endurance limit to energy of of rupture
Series A	0.53	0.174	216	94.0	0.26	512
Series B	0.48	0.138	197	91.8	0.29	900
Series C	0.50	0.128	168	77.6	0.26	825
Series D	0.38	0.98	135	62.3	0.20	553
Series E	0.42	0.115	143	72.7	0.22	573
Series F	0.53	0.148	204	93.2	0.29	783
Series G	0.54	0.146	206	96.8	0.28	713
Series H	0.43	0.141	219	92.2	0.25	500
Series J	0.51	0.139	136	68.8	0.22	715
Series K	0.57	0.156	251	101.8	0.32	746
Average	0.49	0.138	187	85.1	0.26	682
Mean variation from the average, per cent	10.0	10.8	18.0	13.9	11.2	17.3

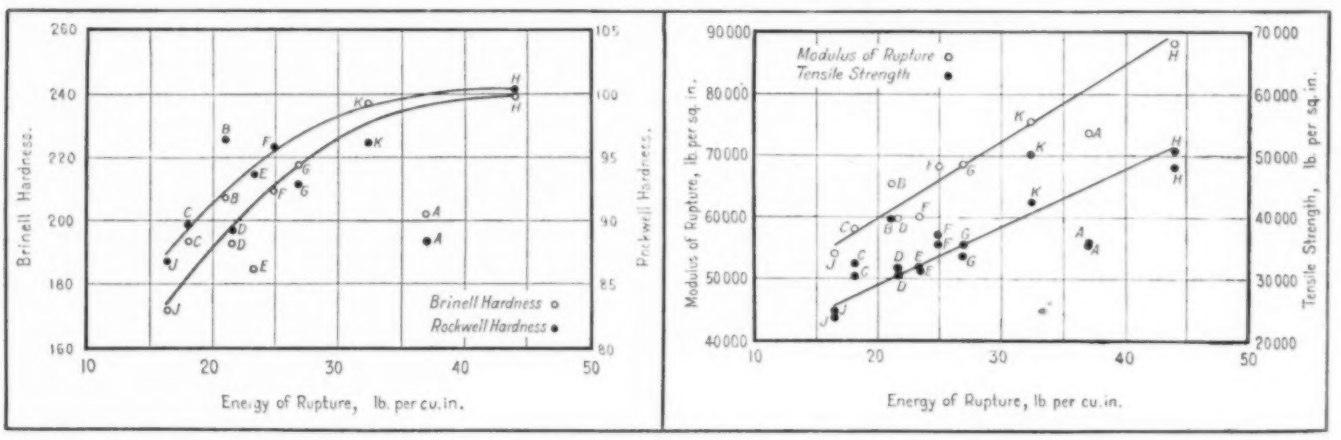


FIG. 30—RELATION BETWEEN ENERGY OF RUPTURE AND BRINELL HARDNESS, AND ENERGY OF RUPTURE AND ROCKWELL HARDNESS. FIG. 31—RELATION BETWEEN ENERGY OF RUPTURE AND MODULUS OF RUPTURE, AND ENERGY OF RUPTURE AND TENSILE STRENGTH

these ratios is about 10 or 11 per cent.

It will be noted that the endurance limit is about 50 per cent of the tensile strength and about 25 per cent of the modulus of rupture obtained from the transverse test.

An attempt was made to correlate endurance limit with chemical composition as given in Table I. No consistent relation was found between endurance limit and combined carbon, graphitic carbon, ratio of combined carbon to graphitic carbon, total pearlite, and ratio of pearlite to graphitic carbon. A possible explanation of this lack of correlation may be the number of chemical and physical variables involved, internal stresses, or perhaps the previous history of the material from which the test bars were cast.

Fig. 28 shows the relation between brinell hardness and tensile strength and modulus of rupture. There seems to be a fairly simple relation between these quantities and the tensile strength curve is fairly consistent. Fig. 29 shows the relation between tensile strength and modulus of rupture and compressive strength. A few of the points do not lie very close to the curves.

Fig. 30 shows the relation between energy of rupture and brinell hardness and Rockwell hardness. Series *H* which contained 1.15 per cent of nickel seems to show particularly high toughness for a given hardness, as contrasted with series *K* which did not contain the nickel but was otherwise practically the same.

Fig. 31 shows the relation between energy of rupture and modulus of rupture and tensile strength. A few of the plotted points do not lie close to the curves.

It is hoped that this article will be looked upon merely as a preliminary survey and that further work on cast iron will be carried on in the near future.

It is quite possible that the maximum temperature reached by the cast iron in the melting process has an important influence on various properties. Perhaps in tests along this line the electric furnace should be used to melt the iron. It would be interesting to note the effect on endurance limit of superheating ordinary cupola iron in the electric furnace.

One of the matters which needs investigation is the influence of heat treatment of castings on the various properties. Perhaps some of the erratic results shown on the curves are due to the presence of internal stresses. A low-temperature anneal might effectively relieve the stress.

Cast iron is complex, both chemically and physically, and at the present time the information available is not precise enough to enable one to say just what the effect will be of varying certain chemical and physical factors. The various chemical ingredients, for instance, can be combined in so many different proportions that the problem is quite complicated.

Considerable work has been done in studying the effect of such alloys as nickel and chromium in producing certain desirable characteristics in cast iron. Such work is certainly of the greatest practical importance.

Another investigation which might prove to be interesting would be a study of the effect of different pouring temperatures, and the effect of various cooling conditions in the molds.

Mechanize Operations in Boiler Foundry

(*Concluded from Page* 740)

After testing the sections, any rough spots are ground off by portable grinders. The castings then are inspected for defects and forwarded to the grinding department where the surface grinding is done. A view of one boiler section just before entering the surface grinder is shown in Fig. 4. The machine is clamped in a frame and as the section slowly passes through the machine ribs on both sides are ground parallel by large diameter abrasive wheels on either side. The whole side is not ground, only the projecting ribs on such parts as the fire box, water connection holes and around the edges. These ribs may be seen in the illustration.

When the sections are ground parallel they are sent to the machining department, a view of one unit of which is shown in Fig. 6, where the necessary holes are drilled, and the water openings into which tapered nipples later are fitted and reamed carefully to size. During the various operations described the work is gaged by inspectors to see that it is being done correctly.

Fig. 1 shows the assembly department where all export boilers are assembled and tested. In this department boilers are assembled during the process of manufacture as a check to maintain the accuracy of the various operations. Boilers are shipped as separate sections, and the necessary parts to make a complete boiler such as doors, smoke hood, nipples, etc., are sent in boxes and crates similar to those shown in Fig. 8. Before crating and after inspection, such parts as doors, hinges, etc., are fitted to the proper sections so that, when on the job ready for installation, each part fits properly.

Melting in the Cupola

(*Concluded from Page* 749)

infers that Ireland used this form of tuyere prior to the introduction of his double tow of tuyeres. A patent was taken out in the United States in 1867 by a Mr. Hibler for a form of center-blast tuyere and reference also is made to a further patented form by Johnson. Thos. D. West made trials with this arrangement in 1893 and other recent attempts have been described in the technical press. Even with elaborate precautions of water cooling and coating with refractory material it is stated that the possibility of ultimate success is not convincing.

Use of auxiliary tuyeres introducing air at different levels, well up the cylindrical portion of the shaft appears to have been introduced first by D. T. Stewart of Glasgow. This arrangement was similar in many respects to a later arrangement patented by Greiner and Erpf. The Greiner construction is illustrated in Fig. 10 and the auxiliary tuyeres are arranged spirally up the walls of the stack. This construction is different from that described in the patent in which the auxiliary tuyeres were arranged in rows at different horizontal levels.

Wages Reach New Peak in 1926

The United States department of labor has issued a comparative statement of wages in the United States and various European countries, with the results of a study of the relation of wages to costs of living in the United States over a period of years.

According to this report wages were at their peak in the United States in 1920, decreased in the following two years, and since 1922 have increased steadily until in 1926 they were 129 per cent higher than in 1913. The summarization for 1927 is not yet available. The cost of living likewise was highest in 1920, falling off in the following two years, and then increasing comparatively little up to 1926. In 1926, with wages per hour 129 per cent higher than in 1913, the cost of living was only 75 per cent higher, so that for his hour of work, the worker could buy 30.7 per cent more than he could in 1913. Between 1926 and 1927 the cost of living dropped about 1½ per cent.

Charles Vickers Says—

Action Of Various Deoxidizers Differs

This Is The Second of a Series of Articles on Practical Brass Founding

SILICON is one of those elements, which, when it constitutes an impurity in copper exerts a highly depressing influence upon its electrical conductivity. According to Barclay the addition of 0.18 per cent silicon reduces the conductivity to 54 per cent of that of pure copper. Now, 0.18 per cent of silicon is an unnecessarily large amount to add to copper to promote soundness in sand castings. A maximum of 0.10 per cent is all that is required and this amount of silicon reduces conductivity to 57 per cent of that of pure copper according to tests made for the writer. Therefore when silicon is selected as the deoxidizer, the addition of 1.00 per cent of 10 per cent alloy cannot be expected to produce castings having good electrical conductivity.

Silicon-Copper Is Variable

The amount of silicon-copper of 10 per cent silicon content that may be used by brass founders to produce sound copper castings is a variable quantity. Some foundries may use 0.75 per cent of this grade of silicon copper, and turn out nice appearing copper castings. Others have reduced it to 0.5 per cent, and still others to 0.25 per cent, but this latter amount is the limit downward for sand castings when the copper is melted in the ordinary manner and is given no preliminary refining. Not only must the greatest care be exercised in melting the copper, but it is not safe to use any but the highest grade of metal. Many strange and unaccountable failures of deoxidizers, so called, to prevent copper from rising and bulging in sand molds are attributable to nothing other than the presence of impurities in the copper. They counteract the effect of the particular deoxidizer that has been added. Quite recently a heat of a commercial copper deoxidizer was divided and shipped to two widely separated brass foundries. In the one a conductivity of over 89 per cent was reported, and completely satisfactory castings were obtained. Men in the other plant felt they had been badly *stung* because in two trials the sprues and risers bulged and overflowed on the floor. Every casting was lost. They were distorted and spongy, and yet the same alloy was used in both places.

Experiences of this sort are familiar to manufacturers of deoxidizers designed for producing copper castings of high electrical conductivity. One founder will show excellent results, another negative results always. One speaks well of the deoxidizer, and the other regards it as a *fake*. Identical brands of copper may be used by the two foundries, and they will both melt carefully. One will be successful, the other a failure, and the whole thing is very mystifying. A little research usually will show that the failure was due to lack of heat. The founder was afraid of getting his metal too hot and *burning* it.

With silicon as a deoxidizer, the more that is found necessary to get sound castings, the lower will be the conductivity of the copper, and the greater the reflection on the skill and knowledge of the founder. If he can reach between 70 and 80 per cent conductivity with silicon alone he really is doing well. In popular parlance he is no slouch of a foundryman, but a conductivity under 80 per cent, is not good enough these days. If it drops below 85 per cent, the castings are not accepted in many instances. The time is approaching fast when better than this will be demanded, and nothing under 90 per cent will be considered. Foundrymen have asked: "Why all this bother about conductivity? We can make castings of 99 per cent pure copper or better, why isn't that good enough for anything?" That question is answered by calling attention to the fact that the electrical conductivity of the 99 per cent *pure* castings might be say, 42.5 per cent or half that of the 85 per cent conductivity now demanded. This 99 per cent *pure* copper is only half as good as the 85 per cent conductivity copper, because for the purposes of the electrical engineer it would be necessary to make larger and much heavier castings to handle the same amount of current. The high electrical conductivity castings of copper, save both copper and electricity because of their lower resistance.

Reduce the Oxide

Silicon must be a very powerful deoxidizer of copper when the addition of as small an amount as 0.25 per cent is sufficient to produce sound copper castings under favorable conditions, and less has been used.

One of the earlier methods of making high conductivity copper castings was to melt it in a noncrucible furnace, then to *pole* it in imitation of the refiner of ingot copper to reduce the oxide formed as a result of melting the copper so that the molten copper in the furnace was of the same composition as the original ingot before it was melted. Usually this is not so, for while copper is highly resistant to atmospheric influences in the cold state it is a changeable metal when exposed to heat. When melting copper the change commences at a dull red heat, when oxides are formed, one red, the other black. The black takes up more copper and is converted into the red or cuprous oxide as the copper melts, so that copper in the molten state contains only one oxide, the red one, CuO. Since the amount of oxide has been increased by melting it follows that the amount of deoxidizer must be increased. If we can reduce the amount of oxide held by the copper we can reduce the amount of the impurity added to remove it and get higher conductivities as a consequence.

Poling reduces the content of cuprous oxide held in the copper. A young tree trunk is thrust into the molten copper with the object of producing gases that boil the copper and also unite with the oxygen and remove it. Poling is a highly

specialized operation, practised by the copper refiner in a bath of molten copper consisting of many thousands of pounds, where it is carried out by experienced men. Even they make mistakes and have to start over again in many cases. It is not to be wondered at if the average brass founder trying it, falls down and does his metal more harm than good, and particularly with alloyed copper, such as brass or bronze.

Highly Skilled Operators

This method has been practised in some foundries for many years, and it is reasonable to suppose that highly skilled operators have been developed in the work, and as a consequence get very good results. The question arises whether these results, good as they may be, compare favorably with those attained by more modern methods.

Much of the efficiency of silicon as a copper deoxidizer is attributable to the film which it causes to form over the surfaces of the molten copper and which insulates it from the gases in the furnace and also from atmospheric gases when the copper is removed from the furnace. Many other elements capable of deoxidizing copper, judging from the heat of formation of their oxides as compared with that of copper oxide, fail to produce sound copper castings in sand molds, because after their application the molten copper surface is left *raw*. It is left absolutely devoid of any sort of covering to shield it against any gases. In fact, some of these elements appear to *activate* the copper, making it absorb deleterious gases more greedily, especially while they are hot, as in the furnace atmosphere.

The result is gaseous copper after it has been poured into the molds, although the deoxidizer used may be one of the most potent of the elements, such for instance, as calcium. The surface film produced by silicon when it is added to molten copper is very valuable to the caster. No matter how much he skims the surface of the metal he never can leave it entirely unprotected. The film forms instantaneously back of the skimmer when it is drawn forward. Clean skimming of molten copper never is advisable, especially while the metal is in the furnace. By exposing the surface to the hot gases all the work of protecting the metal that previously has been done is rendered vain.

In the open flame or noncrucible furnace the surface of the metal may be covered several inches thick with a sticky, lumpy mess that has detached itself from the lining. The lining has failed to stand up, or it has been patched and the patches have come off. Anyhow it is a bad condition and steps should be instituted to remedy the condition. When this situation presents itself some skimming has to be done in the furnace. Otherwise it would be impossible to add a portion of the deoxidizer to the metal while it is in the furnace, and sometimes this action is thought desirable. However, the skimming should not be carried to the point of completely exposing the metal. It should be just sufficient for dropping the deoxidizer into the copper without coming in contact with the slag. In noncrucible furnaces the deoxidizer frequently is added, partly in the furnace and partly in the ladle.

As might be expected it is not so dangerous to skim copper in the open air, as it is while in the furnace. However the ladle never should be skimmed cleanly and then the metal stirred vigorously, for this is a means of churning air into it. There is no standardized way of adding the deoxidizer in these furnaces; some prefer to add it in ladle and furnace as described, others entirely in the ladle, and others entirely in the furnace. Whichever way gives good results is the best way for that particular foundry. Simply exercise common sense about it and worries will be lessened. Exercise of common sense may suggest skimming the ladle after it has been filled from the furnace. It also suggests that if any stirring is going to be done, it should be done quickly and before skimming. After the skimming, the cleaned surface should be covered with charcoal. As some of this charcoal may enter the mold, a skimmer should have been bent previously and shaped to bridge the lip of the ladle. Jabbing and poking at the bits of charcoal floating on the stream of metal with a straight iron bar never is very effective.

Crucible Melting

In crucible melting there is a difference between the natural draft and the blast-driven furnaces. The first type usually is fired with coke and quietness prevails at the top of the crucible. The best copper covering is a 1½-inch layer of charcoal agglutinated with a little borax. Borax glass is best because the ordinary glass acts like popcorn when strongly heated, due to driving off its water of crystallization. In this condition the draft carries it up the chimney where it does no good.

The deoxidizer may be added easily with this sort of melting equipment. It can be dropped into the crucible with tongs, or a phosphorizer can be used. Then the metal can be superheated for a few minutes before the pot is pulled for pouring. If the pot can be poured while carrying a thin covering of charcoal it is certainly advisable. While using some deoxidizers it has been observed that a cleanly skimmed pot of copper carried 100 feet, would pour the first couple of molds normally, the third would spray a trifle, the fourth more so, the fifth would bulge a little. At this stage it would have been economy to have returned the pot to the fire, but it will be several minutes before these phenomena show. The pot cannot wait, it must continue its journey. The string of molds are poured resulting in a couple good at the beginning, and badly mushroomed heads at the finish. If poured from a charcoal covered pot, with sprues and heads covered as soon as poured, all the castings would be sound.

Metal Easily Oxidized

Usually when molten copper sends up a spray after being poured into a sand mold, this will be followed later by bulging, mushrooming or worse. Sometimes this does not happen. We all like to take a chance and that is the reason why production losses often are boosted. Melting copper in natural draft coke-fired furnaces is slow compared with melting in either oil or gas-fired furnaces. This is a drawback to the coke-fired furnace as it favors oxidation of the copper, and this oxidation occurs before the copper melts. Afterward the oxide and copper are mixed. When this occurs to only a small degree no particular harm is done, other than possibly a little extra deoxidizer has to be used. However, the quicker the copper can be changed from the solid to the liquid state, the better, because more surface is exposed when it is solid, and it is quite difficult to protect it. A little salt is useful, but due to the choking fumes it is advisable to use it in small amounts only. In the furnace the fumes are valuable as a protection against both oxygen and sulphur.

When molten copper is forgotten and neglected it can become highly oxidized and this can occur in any kind of a furnace, and has happened frequently. To call copper in a highly oxidized condition oxidized is putting it mildly. The word *burnt* is generally used as being more expressive. Burnt copper cannot be brought back to proper condition by the addition of deoxidizers usually

added to copper. It can be turned into an alloy such as a red brass with phosphorus added to deoxidize. Previous to this addition, common salt must be added to separate the mushy metal from the oxides of the white metals.

Silicon copper is not of the least value for it will pile trouble on trouble. In fact though it is so powerful in copper, it finds small application in alloyed metals for reasons that will be dealt with later. Silicon in the form of an alloy with copper was first introduced about 40 years ago by Alfred H. and Eugene Cowles. They prepared it by the direct reduction of silica by carbon in the electric furnace invented by Alfred H. Cowles. The alloy they prepared was the 10 per cent silicon, 90 per cent copper admixture, which is the best for addition to nonferrous metals. It is sufficiently brittle to be broken easily into small pieces and does not crumble.

Where large quantities of silicon are used as in rolling mills, the richer alloys can be used, such as the 20 per cent silicon copper. The 50 per cent silicon copper is a black alloy and is useful for alloying purposes. It would be inconvenient for adding to copper as a deoxidizer, owing to the difficulty of correctly weighing on brass foundry scales the small quantities required. About 20 years ago the silicon copper produced by the Cowles brothers was discussed by the writer, and many of its applications were described in THE FOUNDRY, March 1908, pages 1 to 4.

Some 14 or 15 years ago, the writer was confronted with the necessity of devising a more efficient copper deoxidizer than any then available commercially. It was expected to be more efficient in the sense of being easy to add to the molten copper which meant it should be in the metallic state. Also it should give conductivities in castings of copper at least equal to the nonmetallic deoxidizers then in use. This was a difficult problem to solve and required some close application, but finally it was thought that good results might be obtained by using silicon to complete deoxidization of the copper and then eliminate the excess left behind. This would work along the same lines as *poling*, but would eliminate the uncertainty as to the proper amount of silicon to add to thoroughly deoxidize, and leave behind merely sufficient to produce the surface film dealt with before in these articles. Some conductivity would have to be sacrificed for the safety film, but it was hoped this would not be any large amount.

The next problem was to discover the best means of removing this excess silicon, bearing in mind that economy was all important. This problem is of the recurring kind, like the decimal of the same name, and there is no end to it even yet when considerable progress has been made. However, a start had to be made and a careful survey of earth's minerals showed there was one, which, if it would only form as a slag in the molten copper before rising to the surface, certainly would remove the major portion of the excess silicon.

This mineral is Wallastonite, Ca Si O_3 and as a preliminary, an alloy was made containing silicon and calcium in the proportions of 7.5 per cent silicon; 2.5 per cent calcium; 90 per cent copper. This was added to copper in the proportion of 1 per cent at first. Later 0.75 per cent was found sufficient. The less used, of course the higher the conductivity of the castings. While this alloy in practice was found to be far from perfect it gave very good results when properly handled. It was made by melting together 75 per cent of 10 per cent silicon copper with 25 per cent of a 10 per cent calcium copper. Later the composition was changed to 9.5 per cent silicon; 5 per cent calcium, and 85.50 per cent copper. No evidence ever was obtained that this last alloy was any improvement. With the first alloy a conductivity of 73 per cent of that of pure copper was obtained on a cast bar. A bureau of standards test gave much higher values in drawn wire. The theory that the excess silicon from complete deoxidation of the copper could be removed in this manner seemed to have some foundation in fact, because of the higher values obtained than with silicon alone. Calcium in itself presents a problem; it *ought* to deoxidize copper and produce sound castings, but in practice it emphatically does not.

Calcium alone appears to be unsuitable as a copper deoxidizer for copper castings made in sand molds. It works fairly well with silicon, but a number of drawbacks develop in practice. It produces the same kind of dross that aluminum does and for the same reason. Silicon might be called a saponaceous element. It produces a lather when added to molten metals somewhat like that produced by aluminum, but on a lesser scale. Still it is advisable to introduce the metal into the mold without agitation. Calcium modifies the lathering effect, but it fails to act as energetically in molten copper as its salts do in soapy water. Its influence does not measure up to expectation in that direction and the result is dross in the castings treated with this deoxidizer.

Establish Headquarters for Iron Institute

Permanent headquarters of the Gray Iron institute have been established in the Terminal Tower building, Cleveland, according to an announcement by Arthur J. Tuscany, manager of the institute. Mr. Tuscany comments as follows:

"After careful consideration of various centers, the executive committee of the Gray Iron institute decided to locate the office of that organization in Cleveland.

Due to its central location it is possible to reach over night from Cleveland most of the important foundry centers of the country. In addition, Cleveland is becoming quite an important center for trade association activities. Many national organizations maintain their headquarters in that city."

The officers of the institute are as follows: Walter L. Seelbach, Forest City-Walworth Run Foundries Co., Cleveland, president; B. H. Johnson, Cresson-Morris Co., Philadelphia, first vice president; A. E. Hageboeck, Frank Foundries Corp., Moline, Ill., second vice president; H. S. Chafee, Builders Iron Foundry, Providence, R. I., treasurer; Arthur J. Tuscany, Terminal Tower building, Cleveland, manager.

Directors are: J. H. Bruce, Bowler Foundry Co., Cleveland; J. L. Carter, Barlow Foundry Co., Newark, N. J.; A. E. Clarke, Des Plaines Foundry Co., Des Plaines, Ill.; J. D. Coltman, Bullard Machine Tool Co., Bridgeport, Conn.; Horace R. Culling, Carondelet Foundry Co., St. Louis; Fred Erb, Erb-Joyce Foundry Co., Detroit; W. J. Grede, Liberty Foundry Co., Milwaukee; A. J. Hartman, United Engineering & Foundry Co., Pittsburgh; John Hartman, Atlas Foundry & Machinery Co., Tacoma, Wash.; Don McDaniel, Hamilton Foundry & Machine Co., Hamilton, O.; Edward B. Sherwin, Chicago Hardware & Foundry Co., North Chicago, Ill.

The Gray Iron institute has been incorporated to promote the interests of the gray iron foundry industry. Included among the activities of the organization as announced in its by-laws are the collection and distribution of information on the manufacture of gray iron castings, the promotion of sound business ethics, merchandising, development of new markets, promotion of uniformity in cost accounting, research to improve quality, establishment and maintenance of standards and stimulation by co-operative effort of the use and sale of gray iron castings.

How and Why in Brass Founding

By Charles Vickers

Wants to Know Losses

Can you tell us what percentage of loss we should expect when melting brass borings? Also what is the loss in melting sheet brass scrap?

Loss sustained when melting brass chips is variable depending on the amount of foreign material mixed therein, such as dust, waste, oil, iron and any other material that may have been picked up. The combustible material burns and of course that weight is lost, so the net loss on the borings should not be calculated as metallic loss. Metallic loss is caused by volatilization and oxidation, and can be controlled to a considerable extent by skillful melting. It may be said that when the loss exceeds 5 per cent, it is excessive; that is 5 per cent on the metallics. It ought to be kept under this figure for clean borings. As sheet brass scrap is not so finely divided as chips the loss should be less, and the figure might be placed at 3 per cent for good melting practice. However, expert melters may better this figure.

Gives Bronze Analyses

Will you kindly advise us the analysis of several bronzes with a copper base, containing tin, lead and zinc; tin and lead, or tin and zinc which have a tensile strength of not less than 40,000 pounds or about 43,000 pounds per square inch?

The following alloys are claimed to have the strength required: Copper, 88 per cent; tin, 5 per cent; zinc, 2 per cent, and nickel, 5 per cent. Ultimate strength 40,700 pounds per square inch; elongation 32 per cent in 2 inches; reduction of area 28 per cent. Ordnance standard alloy, PB88 contains copper, 86 to 89 per cent; tin, 7 to 10 per cent; zinc, remainder; lead, 0.2 per cent maximum; phosphorus, 0.5 per cent. Ultimate strength of this alloy is 45,000 pounds per square inch; elongation 20 per cent in 2 inches; yield point 20,000 pounds per square inch.

Phosphor bronze contains copper, 85 to 90 per cent; tin, 6 to 11 per cent; zinc, remainder; lead 1 per cent maximum; iron, 0.10 per cent maximum; phosphorus, 0.5 per cent maximum. Ultimate strength is given as 45,000 pounds per square inch; elongation 20 per cent in 2 inches; yield point 20,000 pounds per square inch. Phosphor bronze (cast) Pc Grade 1, United States navy, has the following composition: Copper, 85 to 90 per cent; tin, 6 to 11 per cent; zinc, remainder; lead, 0.2 per cent maximum; iron, 0.06 per cent maximum; phosphorus, 0.3 per cent maximum. Ultimate strength of this alloy is 50,000 pounds per square inch; elongation 25 per cent in 2 inches; yield point 25,000 pounds per square inch, minimum.

Bronze No. 4, Rock Island arsenal contains copper, 52 per cent; aluminum, 1.5 per cent; zinc, 41.5 per cent; manganese-copper, 5 per cent (the latter should contain 30 per cent of manganese). Ultimate strength will be around 60,000 pounds per square inch and the elongation 20 per cent in 2 inches.

Find Cause of Trouble

We are having trouble casting aluminum cooking utensils as they show pits like shrinks directly under the outer surface of the metal when they are being polished. We have poured the alloy at varying degrees of heat and have fluxed it thoroughly, using several different fluxes. The alloy itself is sold already mixed and is considered suitable for this class of work. The pig metal when cut in two and the ends polished shows the same sort of holes as the casting. We feel that the metal is to blame, but are told that we are overheating it in melting, or that the sand heaps are at fault, not being properly mixed and conditioned. Do you think it possible to overcome these troubles?

Three possible sources of the trouble are under consideration and these are: The possibility of the alloy being gassed when made and ingoted; the ingot may be blameless, but it is gassed when it is melted in the foundry; something is wrong with the sand, as it gives off puffs of gas that create the holes in the castings. It is necessary to discover which of these three guesses are at the root of the trouble and this can only be done by a process of elimination, or by running experiments. In the end this method will cost less than listening to the opinions of others, and will be much more satisfactory. Eliminate the sand theory first by changing one sand pile to an entirely different sand, but of the same grade, and make a number of castings and carefully watch them as they pass through operations. If holes develop as before, make another run of sand but use a coarser number, or *open up* this new sand pile by adding an equal amount of sand one grade coarser. If the same results are obtained, the sand is not to blame, and some valuable information will have been obtained, as to whether or not, the sand piles are too *close* which is a possibility to be seriously considered.

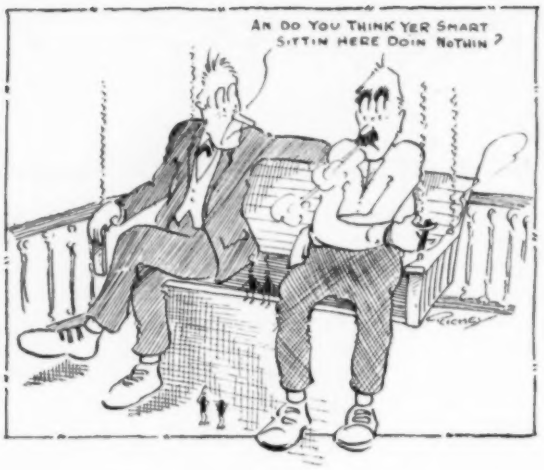
As regards the melting part, it makes a difference whether crucibles or iron pots are used. If the aluminum is permitted to get hot in an iron pot, it will build up in iron, but this does not necessarily mean holes in castings. At no time during the melt should crucible contain metal above a blood red heat. If it gets above this in a crucible, compounds will be formed that are likely to swim into the mold and evolve gas in contact with the moist atmosphere of the mold, or in contact with the sand. The matter of blame as attached to the melting can be decided by a close watch of the operation from beginning to end, taking nothing for granted.

The next move is to get a supply of different metal and run that for a few days. This could of course have been done in the first place, and if the results are negative the other sources investigated. It is evident that if changing the alloy to another source of supply, stops the trouble, the thing to do is to continue with the new metal. If changing the sand eliminates the holes, the thing to do is to change the sand piles. It may prove to be none of the above mentioned possibilities, it may be the flux, so that might be eliminated for a time and nothing used but zinc chloride and only just enough of that to clean the dross of dust.

Must Not Show Cracks

We would like a mixture suitable for hose couplings. It must be a yellow brass that can be expanded after it has been fitted into place, and when this is done it is necessary that the expanded part shall show no cracks.

The following alloy will be found satisfactory: 73 per cent copper; 22 per cent zinc; 3 per cent tin and 2 per cent lead.



Bill Explains Making of Column Cores

By Pat Dwyer

WHEN Bill called around to pay a friendly visit Saturday afternoon he found me engaged in that peculiarly pleasant occupation known when I was a boy among mine own people as *takin' me aise*. They were all hard working men who received all the exercise they needed—and then some—in their daily battle for a living and as a result when they had an hour to spare, they *tuk their aise*.

This point simply is brought up to defend my attitude and to refute an accusation of laziness occasionally leveled against me by an energetic lady who seems to think chairs were invented merely to serve as parking places for fat over-stuffed cushions. Cushions are all right in their place, but between ourselves I have my own idea where that place is.

Usually I have little, or to be perfectly frank, no opportunity of putting my theory into practice, but the lady has been away for the past month and I have proved conclusively, at least to my own perfect satisfaction, that I am absolutely right. At one time or another during the past few weeks I have sat on every cushion in the house and thus, as you might say, have realized to some small extent on the investment. I mentioned this casually in a recent letter to the traveler, just a filler paragraph to make the weekly quota, and now I regret that I did not think of it before. She says she is coming home next week.

A man never realizes his limitations, until he sits down to write a letter to the little pal, who, in addition to other attributes and qualifications, is a bit of a long and short distance mind reader. The choice of subjects is so—so—dash it all, if I may say it, so absolutely poverty stricken. Natural inclination plus lack of opportunity bars me from collecting all the neighborhood gossip. At one time I hit on the brilliant and foxy idea of mailing a newspaper instead of a letter. By return mail I was notified that the lady was living in a civilized community boasting of two daily papers served by the same A. P. service as the paper I had sent. News in my paper was three days old when she received it.

Daily routine is the same whether she is absent or present and she is so thoroughly familiar with the details that any reference to it seems superfluous. In fact the principal argument advanced for taking the trip was the absolute necessity of getting away for a month from the monotonous, treadmill grind of this same deadly routine. Upheld by a stern and uncompromising sense of duty I kept the old home fires burning. True, the actual work was performed by remaining members of the family who gallantly assisted me in holding the fort during this crucial period, but a natural and commendable delicacy prevented me from worrying the lady with the details. Also, a domestic sixth sense developed to a high state of perfection over a period of many years warned me that she would disapprove highly of most of the time and labor saving methods I introduced into household practice.

MORE TO BE PITIED THAN CENSURED

For example, consider the subject of bed making. With the lady, this partakes somewhat of the nature of a sacred rite to be performed with all due attention and deference to precedent and ceremonial. Elapsed time and volume of work vary in summer and winter due to the number of pieces handled.

The various trappings are removed one at a time in the morning and spread around to *air*. Some time later they are returned to place and carefully measured so that the edges hang true, plumb and accurate within 0.001 part of an inch in the distance from the floor on either side. This fine micrometer work takes time. A remarkable, hand-wrought creation, known I believe as a spread and representing countless hours of labor on the part of the lady who made it, is adjusted in place with the same painstaking attention to detail of latitude and longitude, absence of wrinkles and relative position fore and aft. Finally the pillows are set in a straight line, parallel to the head frame and reposing at an angle of 37 degrees, 5 minutes and 3 seconds from the horizontal. A miniature edition of the main spread is draped skillfully over each one.

At night the sequence of operation is reversed. The small spreads, the young hickeys, are removed first, folded once longitudinally, once transversely and then deposited carefully in the east end of an upper bureau drawer. Reference to the east end is only tentative. The bureau has occupied an east and west position for the past two months, but about a week hence it will be moved. I don't know where it is going, but I know it is bound to go. Instead of saying the upper east end I should have said the upper left end. That description applies whether the bureau occupies a position close

to any of the four walls of the room or any of the four corners. At one time or another it has been located in each of these places.

The main spread then is removed and handled in a similar manner. Naturally, on account of the greater area, the chances of error in accurately matching the corners increase in geometrical ratio as the spread is folded and refolded several times. The corner of the sheet is turned back to form a perfect right angle triangle, with the base and perpendicular equal in length and with the hypothenuse extending from a point near the head of the bed, on an imaginary longitudinal center line, to a point on the side of the bed half way between the head and the foot.

All this work is done without the aid of tools or instruments of any kind. While undoubtedly it reflects the greatest credit on the technique, skill and knowledge of the operator, still it presents one serious drawback, one weak link in an otherwise perfect chain.

What, may I ask, is this serious drawback, this weak link, this heel of Achilles in the performance?

"Ask away if you want to," I hear you say impatiently, "What's the answer?"

I thank you gentlemen for the keen interest displayed and I will not keep you waiting. Time, gentlemen, T-I-M-E, the most precious of all commodities, particularly when a sleepy man wants to go to bed, appears to have been overlooked in the schedule.

Let us apply to this problem the acid test of figures that never lie. Assuming that only one hour per day has been wasted in this manner we find that during the past 25 years, each with 365 days plus 6 extra days for leap years, the hours have amounted to 9131. At a modest stipend, wage or honorarium of 30 cents per hour the total bill for bed making is $2739.30, or in round numbers $3000.

That is for only one bed. A conservative estimate should show at least 50,000,000 beds for the 120,000,000 inhabitants of the United States. Multiply 50,000,000 by 3000 and we have the appalling total of $150,000,000,000 wasted in the comparatively short period of 25 years on this apparently insignificant item.

Place that amount at compound interest and the government could cancel the national debt, dig a new channel for the Mississippi, put the American merchant marine on the high seas, lift the American farmer out of the slough of despond, pay the soldier's bonus and put an adequate supply of stickum on postage stamps.

Actuated solely by the purest motive in which patriotism and efficiency are equally mixed I have done my little bit, to the best of my ability, during the past month to cut down this waste of time and effort. The first night I stripped the fancy gadgets from the bed and stuffed them in a drawer where they have remained since. At least I assume they still are there. I have had no occasion to examine the drawer since I closed it. My own immediate belongings are parked on a chair and in a closet in which formerly I considered myself lucky if I could find one unoccupied hook. Now I can spread out, hang garments on separate hooks, also find them later.

COMMENDABLE AND ALL THAT, BUT IS IT NECESSARY?

Under the new dispensation, cost of bedmaking has been reduced 100 per cent. In all due modesty I submit this is rather a remarkable achievement and goes far to prove a theory held by all amateur efficiency experts that a man on the outside with a fresh, unbiased mind, is more competent to handle a problem, than a person on the inside who is too close to the job to have a proper perspective. Women naturally are conservative and for that reason I have little hope that my plan will be continued after next week, but I take comfort in the reflection that I am right and that the reformer and pioneer always has had an uphill fight.

Briefly, my plan is simplicity itself. When the stream of early traffic in the street wakes me in the morning, I turn a sleepy eye on the faithful old watch in the vain but ever trusting hope that I have some time to spare. Reason tells me the watch probably is right, but hope ever springing eternal in the human heart, and never springing more strongly than in the first few waking moments, tells me that perhaps the watch may have gained in the night.

The hope invariably is in vain. Accuracy of the time piece is verified inside of a few minutes by the measured clack-clack of a horse's steel clad hoofs in violent contact with the brick pavement. Up to the present, although sorely tempted at times to lift the window and hurl an empty milk bottle at the disturber, I have restrained myself heroically. If I had a milk bottle handy I might do it, but the effort involved in dashing down stairs, searching for a suitable bottle, flying to the front door and hurling the aforesaid bottle with hearty vigor, well, really that is expecting rather too much of a man the first thing in the morning. I am willing to meet any person half way in any reasonable proposition, but that is going too far. Would you do it yourself? No, certainly not. Then why should I?

Here is where the impatient reader flies up in the air for the second time. He curls his lip—I hope permanently—he curls his lip contemptuously and says, "Why don't the poor ape carry a supply of bottles upstairs at night?"

Friend, you do me a grave injustice. I have thought of that plan many times, but unfortunately at the most inopportune moments. You would not expect me to rush home during the day to attend to it and certainly after I have retired for the night I am not going to arise, creep downstairs, gather up an armful of empty bottles and take them to bed with me.

I never have seen this particular horse—what's the use of getting up to take a look, when I have no deadly missile to throw. Therefore, I cannot describe him from actual observation. From the slow and deliberate one-two-three-four, one-two-three-four manner in which he crashes each shoe on the pavement, I am inclined to the opinion he is at least 8 feet high, 4 feet across the chest and at least 17 feet from the front bumper to the tail light. Apparently he is attached to some kind of a mighty vehicle which my ear tells me is equipped with steel tires on the wheels.

Stamping hoofs and crashing Juggernaut wheels notify me that the time has arrived for me to jump blithely out of the downy couch and buckle on the shining armor for the

day's conflict. Candor compels me to admit that the jump lacks grace and agility, in fact it is more of a wiggle, but it brings me from under the sheet and into a more or less upright position on the floor.

Here is where the superefficiency comes into play. I do not touch the bed after, as previously explained, I have left it in one joyous spring. When the time comes to retire at night, I stretch myself at full length without any tiresome delay, pull the sheet into position and peacefully fall asleep. Efficiency? I'll tell the world! Efficiency plus.

However, as I was saying a little while back, before I was led into this brief digression, none of these topics is of the slightest use to a man confronted with the problem of composing a bright, chatty letter to the chatelaine of the old homestead sojourning temporarily in foreign parts. I mentioned this to Bill while we sat lazily on the veranda and offered magnanimously to consider any suggestion he had in mind. "Well," said Bill, "I'll tell you. This here business of writing letters to your wife is a lot of baloney. You can't tell her anything she does not know already through 40 other correspondents. I quit it years ago. The only letters I write now are in direct desponse to specific inquiries on some phase of foundry practice, and I don't write many of them.

"I had a rather odd inquiry from a man the other day. He wrote that he had been told that a new method had been developed for the manufacture of cores for cast iron columns whereby the cost is reduced to a comparatively inexpensive figure. He wanted to know if I could give him any information on the subject.

"I wrote him that so far as my knowledge extended no new or radical methods have been developed in recent years for making column cores. They still are made either in green sand, dry sand or loam. The method adopted in any foundry and the particular variation of that method is governed by local conditions including the diameter and length of the casting, and the number required. The following list covers practically every method employed and I said he could select from it the one that most nearly meets his requirements.

1—This method involves the use of the minimum amount of rigging and probably is the cheapest where only a few castings are requir[illegible] half cores are made from a dry sand core mixture in a single half corebox. They are dried in the oven and afterward joined to form a whole core. Lengths of pipe, bar, or [illegible] light arbor made in an open sand mold serve as reinforcement for the sand.

2—One or more iron half coreboxes are provided, depending on the daily requirements. Sand to an approximate thickness of one inch is packed against the face. A perforated steel pipe 2 inches less in diameter than the diameter of the core is rapped to a bearing in this sand. Then sand is packed all over the pipe and the surplus is removed with a strike conforming to the circle of the core

DOESN'T THE HORSE RESEMBLE SOME PERSON YOU KNOW?

and with the two lower extremities riding on the upper edges of the corebox. Corebox and core are placed in the oven. After the core is dried it is removed entire from the corebox. A little expense is attached to the making of the corebox or boxes, but afterward the cost of producing the cores is reduced to a minimum both in time and amount of sand required.

3—A number of half cores made in a half corebox first are made and dried. The number depends on the production schedule. The half corebox then is filled with core sand, a vent channel is cut in the center and a small amount of paste is placed close to the edge of the joint. One of the dried halves is placed on the corresponding half in the box and the entire assemblage is rolled over. The half corebox is removed and the complete core is placed in the oven until the upper half has dried.

4—Same as No. 3 with the exception that the upper half of the core is formed in green molding sand and is not dried. Suitable studs are placed on the dry sand half of the core to accommodate any necessary [illegible]plets. Advantages include saving in time, material and fuel. 5—For certain types of columns green sand cores may be employed in the same manner [illegible] are used in making s[illegible] pipe [illegible] r some hydrants and jackets. A [illegible]rforated, stiff, cast iron barrel, with accurately machined bearing surfaces at the ends is revolved in a simple lathe. A stream of sand falling from a carefully calculated [illegible]t adheres to the barrel and is [illegible]d to a proper and uniform diameter [illegible]v a horizontal straight edge. This method is fast and satisfactory for comparatively light, short castings. The principal advantage of this method is that no corebox is required. However, considerable expense is involved in providing a supply of core barrels with machined ends, also iron flasks in which the ends are machined to fit the ends of the core barrels. 6—Green sand is rammed in a half corebox and is reinforced with a cast iron arbor made up of a long, rigid rectangular central member and a number of short chucks spaced about 6 inches apart. The upper half of the core is formed with a strike riding on suitable guides on the upper edges of the corebox. In some instances it is advisable to ram a second half corebox with green sand without any arbor. The two half cores are lifted face to face, the foundry term is *booked* from the resemblance to closing a book, then the entire assemblage is lowered back to the bench with the half containing the arbor underneath. The upper half of the corebox is removed and then the core is lifted out of the bottom half corebox.

7—Loam cores are made by wrapping hay rope around a perforated steel or cast iron barrel and afterward covering the hay rope with a thickness of loam. The principal advantage of this style of core is that it is easily made and quickly dried. Also a core made in this manner is accurate in size and shape and if properly anchored to resist the lifting pressure of the iron, will maintain an even thickness of metal in the casting.

8—Square columns, fluted or undercut introduce other features which affect the methods adopted for making the cores, but I assumed he was referring to round columns. Some time the occasion may arise for touching on this phase of core making and then I'll see about it.

The FOUNDRY Family Photograph Album

Upper Left
WALDO ADAMS
The Adams Co.,
Dubuque, Iowa

Lower Left
E. J. LOWRY
Detroit

Upper Right
A. A. GRUBB
Ohio Brass Co.,
Mansfield, O.

Lower Right
JOSEPH WYNN
Westinghouse
Electric & Mfg.
Co., Philadelphia

A LEXICON OF TECHNICAL TERMS

(*Continued from Data Sheet No.* 732)

Streak

The color of the fine powder obtained by scratching or by rubbing a metal against a hard white surface, is called its streak. The streak of many minerals is different from the color and is an important distinguishing property in mineralogy. The streak of pure iron and the iron carbon alloys is nearly the same as its color, in all cases being some shade of gray.

Luster

The appearance of a freshly fractured surface of a solid substance is called the luster. This is caused by the reflection, absorption, and refraction of light on the surface of the substance and is characteristic of any given substance. Lusters usually are classified as:

Metallic: Those opaque substances having the appearance of a metal; submetallic: Those semiopaque substances which only slightly resemble a metal, and nonmetallic: Those transparent substances which give some brilliant luster different from the appearances of a metal.

All the alloys of the iron carbon series have a typical metallic luster.

Fracture (*Rupture*)

The manner in which a substance breaks other than along cleavage or parting planes; or the irregular surface and its appearance when a piece of metal is ruptured or broken, is called its fracture.

Granular or *intergranular* fracture resembles sandstone. Rupture takes place along grain boundaries instead of across crystalline grains. This property is characteristic of over-heated steel and also is called *coarse grained, rough, bright-crystalline, bright, or granular crystalline.* If especially coarse and bright, it is termed *brilliant, splendant, sappy,* or *fiery,* and in the case of crucible steel that has been held too long in the pot, *scorched.* If fuel has fallen into the crucible heat, a characteristic fracture is noticed which is called *staring. Granular* fracture is found more frequently among the over-heated steels. This means that the crystals making up the aggregate are stronger than the intercrystalline material.

Crystalline, trans-crystalline, or *inter-crystalline* fracture is caused by fracture taking place across the crystals themselves and means that crystals are not as strong as the inter-crystalline material. These fractures are also referred to as *fine-grained, smooth, even or amorphous, porcelanic, or aphanitic,* and due to absence of pronounced luster are also called *dull* and rarely, *gray granular.* This is the most common fracture of the steels.

Silky fracture is caused by the thread-like drawing out of the fragments of the crystals in the act of rupture.

Fibrous and *slaty* fractures are caused by rupture occurring consecutively through distinct layers, showing a fibrous structure. This is also called *barked, laminated,* or *splintery,* and frequently is observed in wrought iron, and to some extent in screw stock steel high in manganese sulphide (MnS), and nickel steels.

Conchoidal fracture is one with irregular elevations and depressions resembling the curved surface of a sea shell. This occurs in hard, brittle, highly elastic materials. Quenched carbon and alloy steels show this fracture to some extent.

(*Continued on Data Sheet No.* 734)

A LEXICON OF TECHNICAL TERMS

(*Continued from Data Sheet No.* 733)

Columnar fracture is one which breaks out showing column structures. This is more characteristic of minerals than for alloys. However, it is noticed to some extent in some nonferrous alloys when broken while hot.

Splintery fracture is one which resembles a splintered piece of wood. Seldom exhibited in metals and alloys. However, it occasionally is exhibited in wrought iron because of its slag content.

Hackly fracture is a rough jagged break. This is exhibited to a considerable extent in unannealed steels and cast iron.

Scaly fracture or flaking is the term used frequently in connection with high-speed steels which have been soaked at high temperatures for a considerable time and afterwards not forged sufficiently to break up the coarse grains.

When a substance breaks suddenly with a single blow with no apparent bending, the fracture is termed *brittle* fracture, or *sudden* fracture. This is in contra-distinction to *tough* fracture which takes place with considerable bending and tearing.

In test specimens, especially tension, there are also some characteristic fractures called *star* fracture, *full cup, one-half cup, three-fourths cup,* etc.

The star fracture is characteristic of specimens whose elastic limit is about 90,000 pounds per square inch.

In fatigue testing the term *progressive* fracture, *detail* fracture, *partial* fracture, and *internal* fracture, frequently are used.

Cleavage

The separation or rupture of a crystal along cleavage planes which represent directions of minimum cohesion. Also called *intra-crystalline* or *trans-crystalline* rupture.

Cleavage in general is limited to directions parallel to the similar and more frequently occurring crystal forms and is definitely characteristic for any substances. Cleavage is not exhibited to any great extent in the irons and steels.

Crystal Structure

The crystal form and the space lattice characteristic of the substance are given in describing the crystal structure. A substance having a definite crystal structure is said to be *crystalline,* or *crystalliform* or in a *crystalline state.* In the space lattice system alpha iron is body-centered cubic; beta iron is body-centered cubic; gamma iron is face-centered cubic, and delta iron is body-centered cubic.

Alloys of the iron carbon series crystallize according to some form in the isometric or cubic system. The crystal forms of this system formed in the iron and steels are the cube and octahedron.

Grain Structure

The arrangement of crystals in the solid aggregate is called its grain structure. Examples: Small uniform grains in worked steels. Untreated cast steel and white iron have long needle-like crystals. Gray cast iron has relatively large irregular shaped grains. Grain structure can be changed completely by heat treatment.

(*Continued on Data Sheet No.* 737)

THE FOUNDRY DATA SHEET, SEPT. 15, 1928

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Saves Time and Money

by

Systematic Flask Storage

By Jack Davis

THE area behind the cupola and the flask storage yard never seem to get the proper consideration when cost reducing systems are installed or when production increasing methods are adopted. Anyone unfamiliar with foundry practice fails to see the real value of the piles of wooden flasks, heaps of bottom boards, and mounds of pig iron and scrap. Nevertheless, considerable profit would be realized if these neglected storage places for material and equipment were kept in order.

The most neglected of the foundry departments probably is the flask storage. I often have wondered why a foundry man will pay a man the wages of a molder and then let him spend an hour or so each day in hunting around the flask yard for the flasks he needed in putting up the day's work. The average mold is made in a flask using four parts, namely the drag, cope, and two boards, and often these must be gathered from as many different locations in the flask yard, depending upon where there were vacant spots when the equipment came out of the foundry after being used the time before.

Many jobs have been delayed while carpenters made new flasks, after a fruitless search for flasks which were known to be around the shop. Such operations cost money and may represent the difference between possible profit and certain loss on the work in hand.

In one shop where the writer at one time was chosen to take the position of gaffer and lead the boys to bigger and better things (a bigger day's work and better castings), the flask yard was in terrible shape.

The first step in cleaning this up was to get all the flasks stacked neatly. This was done by two boys who worked a few evenings after school for a consideration of ten dollars. However, in three weeks' time it appeared that it was a bad investment, however cheap, for the yard looked just like it had before. Firing the man who carried the flasks in and out of the foundry did no good.

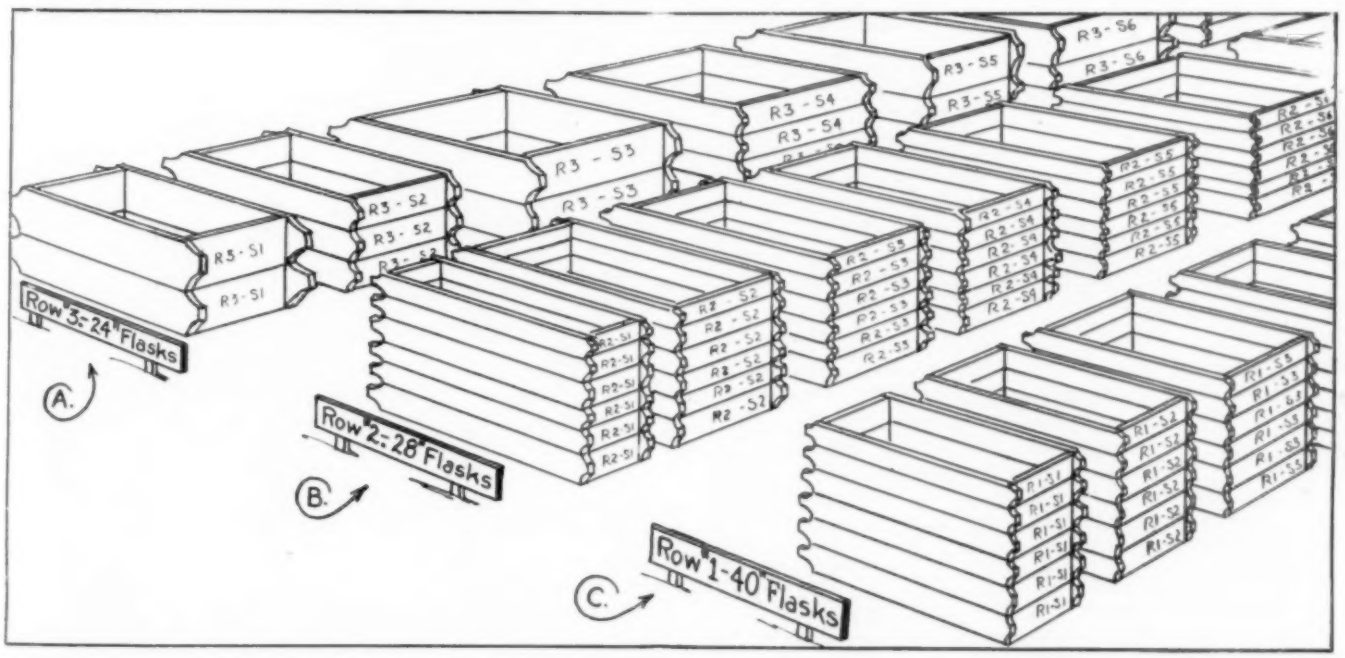
A system then was placed in operation which did work. The yard was divided into a number of rows, one for each length of flask in the shop. Each row was numbered and a small board was nailed to a couple of small stakes in front of each row. The number of the row and the length of the flasks was painted on the board, as at *A*, *B* and *C* in the accompanying illustration.

Then all the flasks of any one length were placed in a single row. This kept the row the same width from one end to the other and helped to maintain a neat appearance. The rows were further divided into sections and only one kind or width of flask was placed in each section, as shown in the accompanying illustration.

After all flasks were stacked in the proper places, the locations were painted on the end, as Row 1, Sec. 1, etc. This enabled the men to return each flask to its proper place in the yard after use. Incidentally all flasks broken or burned were sent back through the carpenter shop where repairs were made when convenient. This avoided making rush repairs when the flask equipment again was needed.

Without making any special effort to remember or memorize the flask locations, we found that in a short time the men knew just where each

(*Concluded on Page* 771)



THE STORAGE YARD IS DIVIDED INTO ROWS WITH ONE LENGTH OF FLASK TO A ROW

Cleaning Room Progress

Aids Production of Quality Castings

By Frank G. Steinebach

Part XIII

IN EVERY class of foundry it is necessary to remove a certain amount of surplus metal from castings. This step in the process of preparing castings for shipment to the consumer, and which is included in the work of the cleaning department of the foundry, is more accentuated in plants manufacturing steel castings than in gray iron, malleable or nonferrous foundries. Steel castings, when received from the shakeout by the cleaning department, are covered more or less with a sand scale. In addition nails, chill plates and reinforcing wires, which are used to reinforce the mold and cores and also to act as a cooling medium at special points on the casting, usually protrude and must be cut off. Fins and small lumps of metal also must be removed. While heavy gates and risers, which are necessary in the production of steel castings, are removed with one of the types of cutting torches which previously have been described in this series of articles on cleaning room equipment, it usually is not possible to make a cut flush with the surface of the casting and a certain amount of excess metal remains after the cutting operation.

Chipping has become one of the important methods utilized in the removal of the excess metal. In the early days of the industry, chipping was a hand operation where the workman cut the surplus metal from the casting with a chisel and a hammer. The method was slow and tiresome, and in fact limited the type of casting that could be produced. Later the pneumatic chipping hammer was introduced and this offered the foundryman an opportunity greatly to reduce the cost of such cleaning operations. With the pneumatic chipping hammer, far greater speed in removing metal is possible. When the hammer is used properly, it does not tire the operator to the same extent as when hand methods were used. In addition, the scope of work possible with the pneumatic hammer exceeds by far that possible with the chisel and hammer. Today the pneumatic chipping has replaced almost entirely the hand methods of chipping.

Removes Cores

While the chipping hammer is used to remove fins, small lumps of metal and parts of gates and risers, it also is used extensively in the removal of cores. This is especially true in the case of steel castings where the high temperature of the metal poured into the mold bakes the cores into an exceptionally solid mass. Core breakers, consisting of a pneumatic chipping hammer, a retainer to hold the chisel in the hammer and a specially designed chisel, also may be used to break cores. The use of chipping hammers makes possible the removal of intricate cores which would be impossible with hand methods. After the cores are removed, the chipping hammer is used to remove the nails, etc., from the inside surface of the casting, as shown in the accompanying illustrations.

As described in Part V of this series of articles, various types of grinding machines also are used to remove surplus metal from castings. However, it is hardly possible to draw a fine dividing line between the work that should be chipped and that which should be ground. Both methods offer possibilities for various types of work and therefore should be studied by those in charge of the cleaning department to determine the method which will show the lowest cleaning cost for the particular work at hand. Where any doubt exists as to which would be the better method to employ, experiments should be conducted to determine the cost and the speed with which the work may be accomplished.

Chipping hammers built by the various manufacturers in general are of somewhat similar design and also are of approximately the same size and weight. For example a hammer with a 2-inch stroke weighs from 11 to 13 pounds, depending on the design of each manufacturer. In general a chipping hammer consists of a handle, which usually is forged, the piston, the valve, the cylinder, the trigger, the throttle, as well as the exhaust, bushing, etc. In some types of hammers the valve is eliminated and the throttle and the piston are the only moving parts of the unit.

Action of the pneumatic chipper is controlled by a trigger located on the handle. This trigger actuates the throttle, also located in the handle and regulates the air input into the hammer. A combination of piston and poppet type throttle valve is used by several manufacturers. The air admitted by the throttle valve then passes through a duct in the handle of the unit to the valve which controls the motion of the piston. Pneumatic hammers are built with the valve in line with the piston or with the valve offset. The valve is operated by constant pressure on its back and intermittent pressure on the front caused by the flow of air through the lower end of the piston.

The variety of machines and tools used in the cleaning room and operated by compressed air direct attention to air compressors. While a

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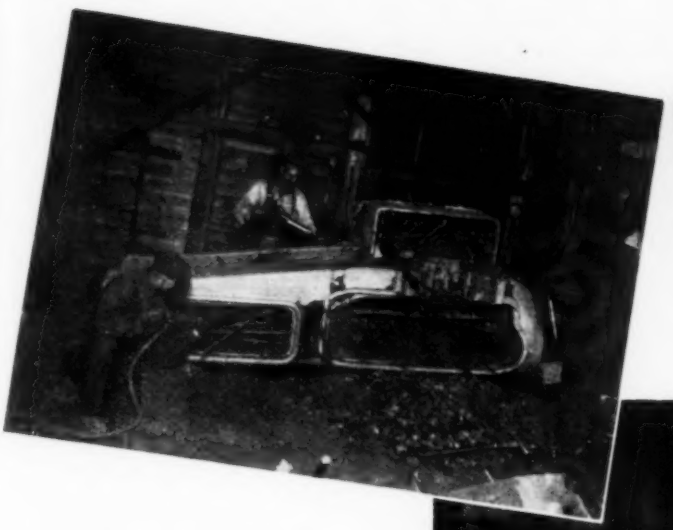


Fig. 96 (Above)—Chipping and Removing Cores From Large Gray Iron Casting. Pneumatic Hammers Are Used Extensively To Remove Cores

Fig. 97 (Above)—Chipping Hammers May Be Used in any Part of the Foundry Where Compressed Air is Available

Fig. 98 (Above)—The Castings Should Be Placed at a Convenient Height for the Workmen

Fig. 99 (Above)—Nails May Be Removed from the Inside of Castings with the Chipping Hammer

Fig. 100 (Above)—Removing Excess Metal from a Small Roll. Fig. 101 (Left)—Chipping Gray Iron Castings

Fig. 102 (Left)—Chipping a Steel Casting.
Fig. 103 (Right)—Pneumatic Chipping Hammers Used in Aluminum Shop

Skill Is Required

To Operate the Cupola

Melting Iron Successfully in the Foundry Cupola Depends on Many Factors Including the Presence of an Intelligent Man on the Charging Platform

By James H. Anderson

MANY articles have appeared in recent years in the columns of THE FOUNDRY relative to cupola practice. Some of them were able and all were instructive as far as they went.

Recently the author of an otherwise able article stated that uniform charging will give uniform results. Within the next line or two he tells you to "put an extra fork of coke on every third charge." Why? He says, "To help hold up the bed." If uniform charging will give uniform results, why not add the one-third of this extra fork of coke to every charge? That would be uniform.

In the opinion of the writer there is only one reasonable excuse for charging an extra fork of coke on any charge and that is when the stock —pig iron or scrap—is in larger pieces than usual. Where the pig iron on any charge includes several heavy sows or several large pieces of scrap, then add an extra fork of coke. This is the only legitimate excuse for using extra coke.

Why Add Extra Coke?

Height of the coke bed in any cupola is governed by the melting zone and the melting zone is governed by blast conditions. In some cupolas the melting zone is located 4 inches above the tuyeres while in others it may be found as high as 18 inches above tuyeres. Why? Because the man operating the cupola with the melting zone 4 inches above the tuyeres is melting iron by air volume and knows how to melt, while the cupola with melting zone 18 inches above tuyeres is operated on an air pressure basis by a man who does not know how to melt iron. If iron is melted to cupola capacity and hot enough for all intents and purposes, what purpose is served by adding extra coke?

If the melting zone has not changed, if the tuyeres are in the regular place and the blower is running at regular speed, if blow pipes have not been changed, why use an extra fork of coke without a reasonable excuse?

All foundrymen are aware that no two cupolas work alike. If you take two or more 40-inch diameter cupolas lined the same, charging door same height, tuyeres area the same, blow pipe the same size, same size blower and charged the same, they will melt the same. Jones & Co. operates a 40-inch cupola, with 3 to 1 tuyere area and a blower capable of delivering into the cupola 220,000 cubic feet of air per hour. The cupola will melt 8 to 10 tons of good hot iron per hour when properly charged, and will not inflict any undue burden on the power plant.

The same sized cupola at the plant of Brown & Co. presents a small tuyere area. Air is driven into the cupola under a pressure of 16 ounces. Even at that the maximum is not over 160,000 cubic feet of air per hour. Approximately 25 per cent of the machinery in the plant must be shut down while the blast is on. Five to 6 tons of poor iron is considered good production. Sulphur content is high, silicon is low and 8 to 20 per cent of the stock charged is oxidized.

How would you expect these two 40-inch cupolas to work the same? The foregoing only represent two points in variation out of a multitude.

Assuming that the bed has burned through in this 40-inch cupola of Jones & Co., it is made ready for charging as follows: Put on remainder of bed until it extends 14 inches above the tuyeres. This coke is loose and under four charges of iron it will settle to 6 to 8 inches above tuyeres. This is a slight excess, but better be safe at this point. Charge the pig iron around the side close to wall, but drop it flat, not on end. When pig iron is dropped on end, it digs into the coke bed and is the cause of cold iron for an hour's melt. Pig iron charged in this manner sinks in the coke bed until it is below the melting zone and has to be melted by molten iron dropping from above. Naturally all the iron is dead or cold.

Assuming that 1200 pounds of the 2000-pound charge is pig iron, this pig iron is charged first and is followed by 800 pounds of fairly heavy scrap, at least as bulky as the pig iron dropped in the center. This heavy scrap and pig will cause the soft bed to sink to a uniform level.

Where the stock is small, scrap fairly light and broken pig iron—260 pounds of coke should be put on. That amount of coke will melt a ton of medium weight pig and scrap. With heavy, large pieces of scrap, or pig iron use 280 pounds of coke.

Succeeding Charges

Second, third and fourth charges are placed in the same manner, observing same care to place pig iron flat around the wall, with scrap in the center. Steel scrap also is put in center with scrap iron, then 260 pounds coke. Never charge above charging door. Wait until stock has dropped low enough to take next charge. No more than 260 or 280 pounds of coke should be used unless as previously stated stock is bulkier than usual. If it is, use the extra fork of coke on that charge and if next charge should contain bulky stock, do the same but under no other conditions, as long as iron is coming down hot and at cupola capacity. Capacity melting ratio falling behind indicates too much coke. Capacity maintained but iron cold shows that more coke is needed.

If capacity melting ratio checks up and if iron is exceedingly hot, leave 50 pounds coke off next charge—this will lower stock to melting zone. Note results and adjust following charges accordingly.

If iron comes cold but to melting capacity, add 50 pounds coke on next charge. This will raise the stock and maintain the bed. Add this 50 pounds to only one charge and note results. When you know the cupola and know how to melt iron you can charge uniformly and get uniform results indefinitely or as long as you keep your cupola clean.

Put 50 pounds of good limestone on the fourth charge. By good limestone is meant limestone containing 93 to 95 per cent calcium carbonate. The remaining 5 to 7 per cent will be silica and alumina and they are the injurious elements. The lower these injurious elements are kept the

better the iron will be. Use 50 pounds limestone on every charge after the third. Some foundrymen commence using limestone on the first charge, but after 30 years' experience the author cannot see the benefit. Limestone is a cleaning or rinsing agent. The intense heat causes it to melt and gather ash from coke and impurities from stock melted and carry it out of the cupola through the slag hole. Why rinse cupola out until there is something there to get out? Claim of the writer is that nothing is there to bother until after the fourth charge has been melted.

No limestone is needed for less than a two hours' heat. There is enough rust, and sand on the pig iron and foundry scrap to produce enough slag for this length of time. However, melting practice outlined in this article is concerned with long heats, 4, 5, 6 hours or longer.

Slag must be kept flowing out of the cupola, through a 1-inch hole in the back, 2 inches below the bottom of the tuyeres and extending downward to the outside at an angle of 45 degrees. Occasionally the slag hole becomes closed with foreign substance. Small coke, cold slag, many things can close it. It is opened again by running a bar through when the slag is up, a point easily ascertained by looking in the tuyere eye. The slag hole should be kept closed until about 8 tons of iron have been melted. As soon as the slag is seen level with tuyeres the slag hole is opened and kept open through the heat. Melting will continue as long as the fluid slag is kept running.

Many foundrymen seem to pick out a num-skull to operate a cupola because they can get him cheap. A man needs brains to operate a cupola successfully. After having had charge for 30 years, the writer never placed any one in charge on the scaffold who did not know enough to use judgment, know when to use extra coke and watch the iron as it ran out of the spout. Many a bottom has had to be dropped and hundreds of thousands of dollars went up in smoke and bad castings because a bright lad was not on the platform.

To keep the cupola lining intact twice as long as usual, never coke the last charge, and as soon as all has reached a white heat, shut off the blast. More fire brick are burned in the cupola at this time than ordinarily would burn in two heats. The blast works directly on the lining at this time. The blast is not needed after the stock turns white. The bed will melt any small amount that may be left. When last dark spot disappears, cut off the blast.

Storing Foundry Flasks Systematically

(*Concluded from Page* 767)

of the most used sizes were located. This greatly simplified the movement of flasks since we could tell a laborer to get a flask from Row 7, Sec. 9 instead of taking a rule and going out with him to hunt.

A chart showing the location of all sizes of flasks may be kept if warranted. It is necessary to keep the space between every two rows wide enough so that the flasks on either side may be carried in or out. Flasks which are heavy or which are used extensively should be kept nearer the foundry door unless they are handled by crane.

Keeping other parts of the foundry yard neat is accomplished by following the old familiar rule of "a place for everything and everything in its place." The kind of pig most used should be kept nearest the cupola, etc. Coke bins should have a floor as the coke will freeze to the ground in cold weather, making it almost impossible to pick it up with a fork. A good woven wire fence makes a neat and cheap coke bin. Sand and material of that kind should be kept in bins instead of piles since a neat pile of this material will spread over a lot of territory in a short time.

Cleaning Room Program

(*Concluded from Page* 768)

large volume of air is utilized in other foundry departments, such equipment as the sandblast, and pneumatic grinders, chippers and hoists, place a heavy load on the air compressing equipment. The design of air compressing equipment varies considerably with the various manufactures, as well as with the performance which will be required in operation. Such variations in equipment and the many factors which govern the operation of compressors, make it imperative for the foundryman to study the problem carefully to determine the equipment best suited for conditions existing in his shop.

This is the thirteenth of a series of articles on cleaning room equipment. The fourteenth will appear in an early issue.

Sells Sand Machines

The Royer Foundry & Machine Co., Wilkes Barre, Pa., has sold sand separators and blenders to the following companies: Canadian Steel foundries, Ltd., Longue Pointe, Que.; Davenport Machine & Foundry Co., Davenport, Ia.; Dayton Bronze Bearing Co., Dayton, O.; Dominion Engineering Works, Ltd., Rockfield, Que.; Harris-Seybold-Potter Co., Seybold Machine Co. Division, Dayton, O.; Rob't Holmes & Brothers, Inc., Danville, Ill.; Muncie Foundry & Machine Co., Muncie, Ind.; North & Judd Mfg. Co., New Britain, Conn.; Piston Ring Co., Muskegon, Mich.; Semi-Steel Casting Co., St. Louis; Southern Desk Co., Hickory, N. C.; Western Enterprise Engine Co., Los Angeles; Westinghouse Electric & Mfg. Co., Essington, Pa.; Wright Aeronautical Corp., Paterson, N. J.; U. S. navy yard, Washington.

Book Review

Bibliography of Crystal Structure, by Jared Kirtland Morse, paper, 164 pages, 6 x 9 inches, published by the University of Chicago Press, Chicago, and supplied by THE FOUNDRY, Cleveland, for $3, and by the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster, London, for 15s.

The X-ray analysis of crystals was developed first in 1913, and since that time its rise has been rapid. Although much work already has been accomplished in this field, the work remaining to be done is enormous. Some work has been done in this country by several investigators, but it is only recently that a laboratory has been established primarily to carry on investigations of crystal structures at the University of Chicago. This book is published as a bulletin of that institution and is divided into three parts. The first part gives a brief account of the work and program of the crystal structure laboratory. The second part presents reprints of a series of papers on the crystal and molecular structures of organic and inorganic compounds, and the third part contains a bibliography of the whole field of crystal structure as well as related topics of atomic dimensions and molecular structure.

French Foundrymen Meet

The annual convention of the Association Technique de Fonderie will take place in Paris on Oct. 26 and 27. Three sessions will be devoted to the discussion of papers, and the annual banquet will take place on the evening of Saturday, Oct. 27.

Directs Cleveland Office

R. E. Prussing, one of the vice presidents of the Whiting Corp., Harvey, Ill., has been placed in charge of the Cleveland office of that company. He replaces R. P. Dryer who has resigned. Mr. Prussing has been with the Whiting company for the past twenty years both as engineer and as district sales manager.

Foundry Count

(*Concluded from Page* 745)

centers as Los Angeles, Milwaukee, Buffalo, Newark, N. J., Dayton, O., and Rochester, N. Y. In the leading municipalities, using the scale of industrial activity, the decrease in number of foundries in many cases is apparent. It is in these same centers where the great increase in plant capacity, consolidations and similar trends have been noted.

The past two years have seen competitive conditions in the gray iron foundry industry much more marked than at any time since the war. Close prices have made it extremely difficult for small or poorly equipped shops to make a profit. Similarly, larger establishments have found it desirable to increase their unit production and thus have expanded their capacity, removing some of the available tonnage. Accordingly, the mortality among small gray iron foundries has been more accentuated than in any other single branch of the industry. In 1926 there were 4044 gray iron foundries listed in the United States and a total of 4457 in the United States and Canada. In 1928 the total count of gray iron shops is 3835 for the United States and 4243 for the United States and Canada. It will be noted that the decrease in number of gray iron foundries listed is greater than the decrease in the total number of all classes of foundries.

Among the various states, Pennsylvania still is the leading gray iron foundry center with Ohio second, New York third, Illinois fourth and Michigan fifth.

A comparison of the other classifications shows some exceedingly interesting trends in the past two years. The total number of electric steel foundries has increased from 182 to 195 in the United States and similarly in Canada 18 electric steel foundries are listed in 1928, compared with 17 in 1926. This gives a total for both sides of the border of 213 electric steel shops at present in operation compared to 199 two years ago.

The total number of foundries melting aluminum also has shown an increase. The total for the United States and Canada at present is 2655 compared to 2637 in 1926, while in the United States alone 2424 foundries at present melt aluminum, compared with 2404 two years ago.

The number of foundries devoted exclusively to nonferrous metals has increased from 1487 in 1926 to 1495 in 1928 in the United States and Canada. The United States shows one less shop this year than two years ago, while Canada shows a gain of nine nonferrous foundries. The total number of nonferrous departments has decreased slightly. In the United States and Canada together 2052 nonferrous departments are listed this year, compared to 2138 two years ago. The total for the United States in 1928 is 1817, compared to 1895 in 1926.

Eastern cities, in general, have a greater number of nonferrous foundries as is shown by the roll call of the cities in Table IV. Chicago leads with 101 shops, with New York City second with 76, Cleveland third with 74 and Detroit fourth with 66. Milwaukee has shown a marked gain in the total number of nonferrous foundries, an increase from 37 to 48. Similarly Toronto has moved up from nineteenth to eleventh place, increasing from 19 to 28 nonferrous foundries. Five cities of the country have more than 50 shops, fourteen more than 25, and twenty-eight more than 15 nonferrous foundries.

Malleable iron foundries, which showed a gain in 1926 over 1924 have dropped back. Malleable shops listed in the United States total 189, compared with 214 in 1926. Totals for the United States and Canada are 204 for 1928 and 230 for 1926. Similarly, the number of steel foundries active at this time is slightly less than two years ago. A total of 345 steel foundries in the United States and 24 in Canada gives 369 total for both sides of the border, compared with 380 in 1926.

Table VII

Foundries in United States

1928

Gray Iron	3835
Malleable	189
Steel	345
Electric Steel	195
Exclusive Nonferrous	1420
Nonferrous departments of other plants	1817
Aluminum	2424
CANADA	
Gray Iron	408
Malleable	15
Steel	24
Electric Steel	18
Exclusive Nonferrous	75
Nonferrous departments of other plants	235
Aluminum	231

Describes Core Oils

Spencer Kellogg & Son Inc., Buffalo, recently have published an interesting booklet describing their linseed base core oil. The first portion of the publication is devoted to interesting historical information regarding the century of service of the Spencer Kellogg company, in the manufacture of linseed oil. The second portion of the booklet describes the core, the quality that the core binder must have, different types of core binders, how a linseed base core oil works, and the core oils manufactured by Spencer Kellogg & Son, Inc. The publication is illustrated with photographs of the plants at Buffalo, Minneapolis, Edgewater, N. J. and Superior, Wis. Specifications for various brands of core oil manufactured by Spencer Kellogg & Son Inc., are given.

Eastern Company Lists Veteran Employes

Long and efficient service is a source of pride both to the man and to the company for which he works. Many companies have large rolls of faithful employes, but few can boast of a list of 82 active wage earners of over 25 years of employment whose aggregate years of service totals 2702 years, or an average of 32.9 years. This record is offered in a compilation recently made by the Joseph Dixon Crucible Co., Jersey City, N. J. The list includes 21 women whose average years of service total 34.2 years, and 61 men having an average of 32.5 years service. It shows two employes who have served the company for over 50 years, 29 from 35 to 50 years, and 51 from 25 to 35 years.

Ceramic Society to Hold Annual Meeting

The American Ceramic exposition will be held in connection with the thirty-first annual convention of the American Ceramic society, Feb. 4-9 inclusive, at the Stevens hotel exhibition hall, Chicago. Plans for the exhibition call for about 150 exhibition booths on over 32,000 square feet of floor space. Refractories, tile, brick, glass and pottery are products scheduled for display. Convention meetings of the society will be so arranged that part of each day will be devoted to inspection tours.

Starts New Building

The Chain Belt Co., Milwaukee, has started work on a new building at its works at Thirty-ninth and Orchard street, the fourth unit projected in a general plan for extension. The new building, 104 x 150 feet, will be modern in every respect. At present there are five buildings on this tract, a malleable iron foundry, an assembly plant, the general engineering building, a cafeteria, and a 3-story building which houses the drafting room, pattern shop, and coreroom. This company has another plant on the Sixteenth street viaduct, Milwaukee, and one at Cleveland.

WHAT OTHERS ARE THINKING

Abstracts Selected from the World's Foundry Literature

Study Diecasting Production

Properties and Production of Aluminum Diecastings, by S. L. Archbutt, J. D. Grogan and J. W. Jenkin. Paper presented at the annual meeting of the British Institute of Metals held at Liverpool Sept. 5 and 6, 1928.

The paper describes an investigation of the production and properties of aluminum die castings made in permanent metal molds under gravity feed without external pressure, and the hot shortness of aluminum diecasting alloys. Five alloys were employed containing 4 per cent copper, 8 per cent copper, 12 per cent silicon, 4 per cent copper and 3 per cent silicon, and Y-alloy, a British aircraft alloy containing 4 per cent copper, 2 per cent nickel and 1.5 per cent magnesium. Two types of castings were investigated; a shouldered test piece of circular section for testing direct without machining, and a tubular casting requiring cores and incorporating flanges and changes in sections which cause difficulty in casting.

Design and treatment of molds, mold temperatures, pouring temperatures, stripping, etc., and the effect of alloy composition on these are described. Satisfactory castings were produced in the tubular form from all alloys studied. With the test piece form castings of satisfactory mechanical strength were obtained in the Y-alloy, 12 per cent silicon, and 4 per cent copper, 3 per cent silicon, but less satisfactory results were obtained with the binary copper-aluminum alloys owing to hot shortness. Hot shortness only is exhibited at temperatures close to the commencement of melting. Within narrow temperature ranges, the impact strength falls rapidly from the maximum striking energy of the machine to zero or nearly so at the commencement of melting. The range over which the rapid fall in impact strength takes place varies from 5 degrees Cent. with the 12 per cent silicon alloy to 45 degrees Cent. with the L5 alloy, containing 2½ to 3 per cent copper and 12½ to 14 per cent zinc.

Produce Light Pistons

The Economic Production of Pistons in Light Metals, by P. M. L. *La Revue de Fonderie Moderne*, Paris, July 25, 1928.

There is a growing tendency to make pistons and other automobile parts with light alloys, particularly aluminum alloys. It has been found that the die-casting process is one of the best methods to use for the manufacture of such parts. The use of sand molds sometimes results in larger grains in the structure of the pistons, which are detrimental to the properties of wear and of hardness. Castings also have been made in metal molds with sand cores. However, the die-casting method has been found to be economical and is used to a great extent in this field.

The molds usually are made of cast iron. A table is included which shows the compositions that have given the best results. Cores should be tapered to facilitate the drawing. The parts constituting the molds should be arranged so as to minimize machining. The number of those parts should be as small as possible. The walls of the molds should be as thin as possible and the number of risers should be limited. Composition of the metal of the mold should be chosen in accordance with the number of pieces to be cast and their shape. Metal should be as hard as possible. A table shows various compositions of metal used. The molds can be finished more quickly by grinding than by other methods. The article describes preparation of the molds.

Study Nickel Additions—II

The Influence of Nickel on Iron-Carbon-Silicon Alloys Containing Phosphorus. By A. B. Everest and D. Hanson, *Foundry Trade Journal (London)*, *May* 10, 1928.

This is the second part of the paper by the authors and the investigations were carried out on a base refined pig iron containing total carbon 3.05 per cent; silicon, 1.87 per cent; manganese, 0.75 per cent; sulphur, 0.09 per cent, and phosphorus, 0.24 per cent. Twelve castings were made in all by adding 0, 1, 2 and 3 per cent nickel to the original iron, and again to the same iron with the phosphorus made up to 0.5 and 1.2 per cent. Conclusions of the authors are that phosphorus renders the iron susceptible to chill as in the case of the tests on American washed iron; producing white fractures in the ⅛-inch sections. With all the phosphorus contents however, 1 per cent nickel is effective in counteracting this influence. Increasing phosphorus rapidly impairs the machinability of this iron as measured by drill hardness. Small additions of nickel further increase this drill hardness by hardening the matrix of the iron. Phosphorus also has a general hardening action on all sections as measured by the brinell test. Its action is not marked on the heavier sections of the castings. Nickel again shows a regular hardening action on all sections except where chilling the casting has produced white iron, when nickel is effective in softening this iron. Nickel and phosphorus both show a refining action on the graphite in the iron but with a higher phosphorus the effect of nickel is small, and inappreciable when 1.2 per cent phosphorus is present.

Diecasts Copper-rich Alloys

Diecasting of Copper-rich Alloys, by R. Genders, R. C. Reader and V. T. S. Foster. Paper presented at the annual meeting of the British Institute of Metals held at Liverpool Sept. 5 and 6, 1928.

This paper deals with some portions of a general investigation of die casting copper-rich alloys. Exploratory examinations of a wide range of alloys in the form of chill cast bars and die-cast, test pieces has indicated that a variety of alloys exists suitable for die casting which offer mechanical properties to meet varying requirements. The aluminum brasses which were examined in greater detail have advantages in their range of properties, high proof stress, slow rate of attack on mold and core materials, and cheapness. Mold and core materials were tested by immersion in molten alloys, both at rest and in continuous motion. High carbon steel and special steels of the heat resisting type showed little deterioration under the conditions of the tests while low carbon steel and engineering steels were attacked rapidly. The behavior of cast iron in molten aluminum bronze largely was influenced by the phosphorus content of the iron.

Describes Pouring Technique

Die Giesstechnik fur Gusseisen, by J. Pettin, *Die Giesserei*, Dusseldorf, Aug. 3, 1928.

This article constitutes a paper that was presented at the May meeting of the German Foundry Owners' association. The first part of the article describes the theoretical considerations involved in pouring a mold. The author then gives a detailed explanation of an investigation carried out to determine the effect of various factors such as gate and riser size, size of runners, metal entering the mold from above or below, etc. A number of tables, diagrams, and equations present the data obtained from the investigation.

From data obtained through the tests performed, diagrams are arranged, showing the rate of metal flow through gates of various cross section, and gate size for castings poured by hand. The application of the results obtained to practical foundry work are given and include a number of specific examples.

Develops Pouring Spout

Improvement to the Molds Used in Centrifugal Casting. La Revue de Fonderie Moderne, Paris, March 25, 1928.

This is a description of a patented invention which applies especially to the filling of molds for cylindrical castings whose inside diameter is small in comparison to its length. In these circumstances the spout which conducts the molten iron to the bottom of the mold tends to deflect. The improvement consists of a ball fixed to the end of the spout which supports the extremity of the spout on one point only against the inside of the mold. The fixation of this ball is contrived in such a way that when the spout is taken out of the mold the ball and its attachment can be released and passed over the ring which forms the entrance to the mold.

The Shakeout

DAN M. AVEY, Editor

PAT DWYER, Engineering Editor
FRANK G. STEINEBACH, Associate Editor

CHARLES VICKERS, Nonferrous Editor
EDWIN BREMER, Associate Editor

¶Figures Not Infallible

FOUNDRY pig iron production for the first half of 1928 fell below the tonnage for both the first and second half of last year, according to statistics recently published by the American Iron & Steel institute. The total production of foundry iron for January-June, 1928, is given as 2,105,398 tons, compared with 2,743,206 tons during the corresponding period in 1927. On the other hand, malleable grades showed an improvement during the first half of 1928, the production for that period being given as 946,599 tons compared with 844,068 tons in the same period a year ago. Production of ferroalloys also showed a gain.

IF PIG iron production is accepted as a reliable barometer of business conditions, it would appear that gray iron foundries experienced a marked decline in the tonnage of castings produced during the first half of the year. In the face of reports received from foundries throughout the country and judging by production reports of manufactured lines requiring large tonnages of castings, this conclusion seems inaccurate. A further investigation and a study of conditions in the pig iron market thus far this year will reveal factors which probably have caused a substantial difference in the tonnage of foundry pig iron produced and the total foundry iron consumed during the six months period which ended June 30.

PIG iron prices in July were off from 75 cents to $1 on quotations in January. The slight declines in price during the spring and early summer perhaps had a tendency to cause consumers to hold off buying until a lower price was reached. The truth of this assumption is shown by the recent buying movement which followed a 50-cent raise in the price of pig iron. The policy of hand-to-mouth buying undoubtedly has become more general with the result that foundries have been melting stocks on hand, metal that was produced in 1927. Labor day found many foundries operating with exceptionally small quantities of iron on hand, one large producer of motor cars keeping only five days' supply in the yard. When these factors are taken into consideration and when it is noted that a low scrap price for the period probably indicates that more scrap was melted, it will be realized that gray iron foundry business was much better than foundry iron production indicates.

¶Caring for the Injured

INFLUENCED by the work of the National Safety council and similar organizations, and also by insurance laws in effect in many states, much progress has been made in the foundry industry in the reduction of accidents. This is especially true in the majority of larger plants where a safety department is provided to carry on educational work among the employes and where hospital facilities are provided with a registered nurse in charge to give close attention to even the most trivial accidents which may occur in the plant. Reports from many companies show that expenditures for this type of work pay excellent dividends in reducing lost time accidents and preventing serious complications from minor injuries.

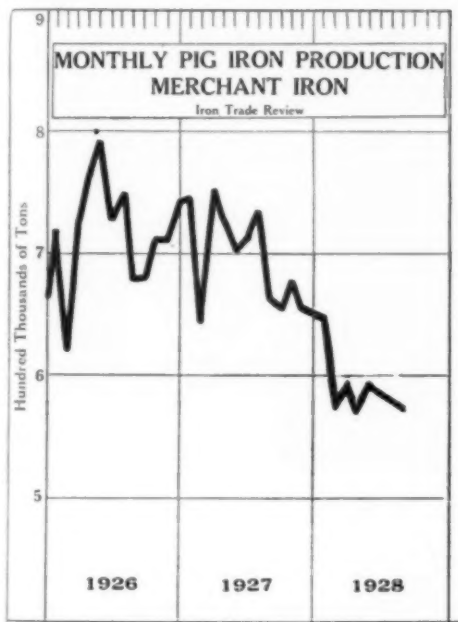
HOWEVER, it is a good policy for a number of men in each plant to be familiar with first aid methods of treating the injured, particularly those establishments not in a position to maintain a hospital organization. Surgeon General H. S. Cumming of the United States public health service, in a recent bulletin urged that everyone learn the first principles for the temporary care of injured persons, using simple, common sense methods based on the principles of medicine and surgery. He stated that prevention is the important thing, but as the minimum never will be zero, all should understand the following first aid principles: Cleanliness in caring for open wounds; control of hemorrhage by pressure and position of the injured part; treatment of shock by keeping the patient at rest and warm and by giving simple stimulants; artificial respiration in asphyxiation, electric shock, etc., combined with the use of pure oxygen in carbon monoxide cases; treatment of burns; immobilization of dislocations and fractures; and transportation by methods that will not increase the extent of the injury.

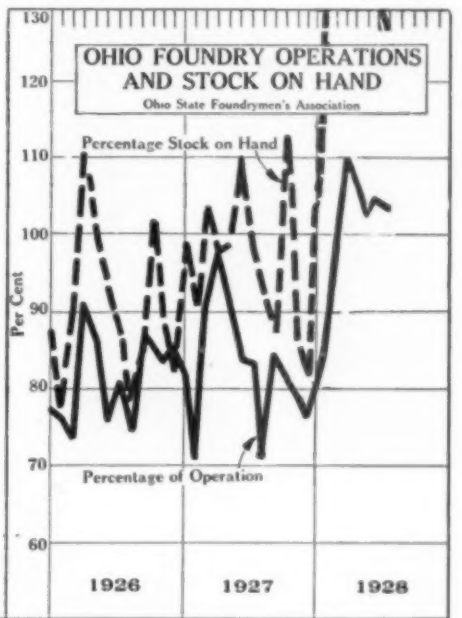
Trade Trends in Tabloid

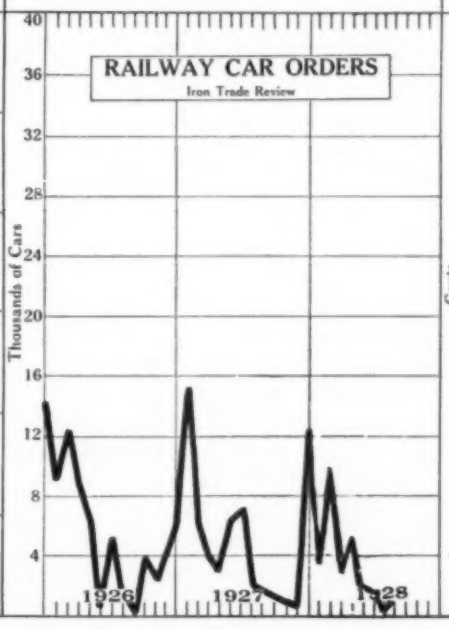
EARLY fall gives indication of sustained activity in foundry lines. Purchases of pig iron have increased, indicating the expectation of steady business going to iron foundries. Brass ingot purchases reflect a similar optimism on the part of nonferrous foundries. All factors tending to support this assumption seem sound. With freight car loadings at a peak and a scant surplus of cars, the announcement of the American Railway association, banning the use of wooden cars after Jan. 1, 1931, promises a replacement demand for cars numbering over 300,000 within the next two years. It is expected that within the next three or four years from 600,000 to 700,000 cars will be placed with carbuilders. Pig iron production for August showed a slight increase over the preceding month, according to *Iron Trade Review*. The output for July was 3,072,711 tons, compared with 3,136,008 tons for August. On a daily average basis, the increase of August over July was 2041 tons per day or 2.06 per cent. Output of merchant iron in August was 561,821 tons compared with 584,611 tons for July. Average New York prices for nonferrous metals during August, according to *Daily Metal Trade*, follow: Casting copper, 14.376c; electrolytic copper, 14.75c; Straits tin, 48.038c; lead, 6.248c; antimony, 10.093; aluminum, 23.90c. Zinc averaged 6.249c, E. St. Louis.

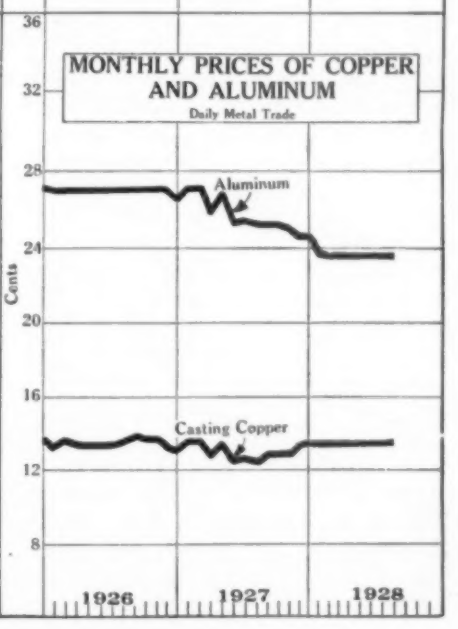
RAW MATERIAL PRICES
Sept. 7, 1928

Iron	
No. 2 foundry, Valley	$16.75 to 17.00
No. 2 southern, Birmingham	16.25
No. 2 foundry, Chicago	18.00
No. 2 foundry, Philadelphia	20.26 to 20.76
No. 2 foundry, Buffalo	17.00 to 17.50
Basic, Valley	16.00 to 16.50
Basic, Buffalo	17.00
Malleable, Chicago	18.00
Malleable, Buffalo	17.50 to 18.00
Coke	
Connellsville foundry Coke	$4.00 to 4.85
Wise county foundry coke	4.50 to 5.25
Scrap	
Heavy melting steel, Valley	$14.00 to 14.25
Heavy melting steel, Pitts	16.00 to 16.50
Heavy melting steel, Chicago	12.75 to 13.25
Stove plate, Buffalo	13.75 to 14.25
Stove plate, Chicago	11.50 to 12.00
No. 1 cast, New York	13.00 to 13.50
No. 1 cast, Chicago	14.50 to 15.00
No. 1 cast, Philadelphia	15.50 to 16.00
No. 1 cast, Pittsburgh	14.25 to 14.75
No. 1 cast, Birmingham	13.00 to 13.50
Car wheels, iron, Pittsburgh	15.00 to 15.50
Car wheels, iron, Chicago	13.00 to 13.50
Railroad malleable, Chicago	13.00 to 13.50
Agricultural Mal., Chicago	12.25 to 12.75
Malleable, Buffalo	14.75 to 15.25
Railroad malleable, Pitts	14.00 to 14.25
Nonferrous Metals	Cents per pound
Casting copper, refinery	14.35 to 14.40
Electro copper, producers	14.75
Straits tin	47.37½ to 47.50
Lead, New York	6.40
Antimony, New York	10.25
Nickel, electro	37.00
Aluminum, No. 12, producers	23.00
Aluminum, No. 12, remelt	15.00 to 15.50
Zinc, East St. Louis, Ill.	6.25









Comings and Goings of Foundrymen

Men of the Industry, Whose Activities Are Making Foundry History

GEORGE BATTY, recently appointed research director of the Steel Castings Development bureau, 502 Stock Exchange building, Philadelphia, as was mentioned in the June 15 issue of THE FOUNDRY, was graduated from the Sheffield Technical school, England, and for many years has been employed successfully as steel maker, works manager, and consultant both in this country and abroad. The members of the Steel Castings bureau are as follows: Atlantic Steel Castings Co., Chester, Pa., Crucible Steel Casting Co., Lansdowne, Pa.; Treadwell Engineering Co., Easton, Pa.; Pennsylvania Electric Steel Castings Co., Hamburg, Pa.; Dodge Steel Co., 6501 Tacony street, Philadelphia; Riverside Steel Castings Co., Newark, N. J.; Deemer Steel Casting Co., New Castle, Del.; Empire Steel Castings Co., Frush Valley, Reading, Pa. These companies are financing an investigation of the manufacture of steel castings with a view to improving the quality of the product to broaden and strengthen their field of useful service.

GEORGE BATTY

Benjamin F. Faunce has tendered his resignation as superintendent of the car department of the Cambria plant of the Bethlehem Steel Corp., Johnstown, Pa., to become associated with the Brown-Fayro Co. Mr. Faunce was graduated from the University of Maine after which he was employed by the Harrisburg Foundry and Machine Co., Harrisburg, Pa. He also was connected with the Pennsylvania Steel Co., Philadelphia, now the Bethlehem Steel Corp., Westinghouse Electric and Mfg. Co., East Pittsburgh, Pa., and Carnegie Steel Co., Braddock, Pa., in various capacities. In 1921 he organized the Fayro Machine and Engineering Co., Johnstown, Pa., of which he was president. This company was later merged with Brown Equipment Co. and became the Brown Fayro Co. Mr. Faunce hereafter will be actively interested in this concern. At present he is chairman of the board of directors.

Samuel S. Little has been made sales manager for Service Foundry Co., Bedford, O. Mr. Little has been employed as metallurgist and foundry engineer for the past eight years in various organizations.

Richard H. Dana, formerly vice president and treasurer of Hodge and Dana, Inc., New York, has taken a position with the Robins Conveying Belt Co., New York and will specialize in the sale of screens.

P. S. Menough has been appointed assistant to the president of the Duraloy Co., Pittsburgh. Mr. Menough is a graduate of Cornell university, and for the past nine years has been employed as chief engineer of the Eastern Malleable Iron Co., Bridgeport, Conn.

Paul A. Ivy has been appointed vice president of the National Cast Iron Pipe Co., Birmingham, Ala. Mr. Ivy has been associated with the cast iron pipe industry for the past 21 years. He was employed by the Dimmick Pipe Co. and the American Cast Iron Pipe Co., Birmingham, Ala., and James B. Clow & Sons, Chicago, in various capacities. Mr. Ivy began his career as a pipe salesman with the Dimmick Pipe Co., Birmingham, Ala., and later with Miss Charlotte Blair founded the American Cast Iron Pipe Co., where he assumed the position of general manager and secretary of the company. He remained with the firm for 20 years, leaving the organization in 1927 to accept a position with the James B. Clow & Sons, Chicago. This company recently purchased the National Cast Iron Pipe Co., Birmingham, Ala., and Mr. Ivy was appointed vice president, with offices in Birmingham.

Will Show Castings at Philadelphia

The Electric Steel Founders' Research group which is composed of the Fort Pitt Steel Casting Co., McKeesport, Pa.; Lebanon Steel Foundry, Lebanon, Pa.; Sivyer Steel Casting Co., Milwaukee; Michigan Steel Castings Co., Detroit; and the Nugent Steel Castings Co., Chicago, plans to exhibit at the National Metal exposition to be conducted by the American Society for Steel Treating at Philadelphia during the week of Oct. 8. The castings shown will illustrate the kinds of products made by group foundries. The exhibit will be in charge of Director R. A. Bull.

PAUL A. IVY

Accepts Sales Position

Charles J. Arthur recently resigned as sales engineer for the A. R. Amos, Jr. Co., Philadelphia, and has accepted a position as salesman for the Wagner Electric Corp., St. Louis, at the Philadelphia office. Mr. Arthur was graduated from the University of Pennsylvania, in 1923. Since his graduation he has been connected with the American Telegraph & Telephone Co., and Philadelphia Electric Co.

National Safety Council Meets in New York

The seventeenth annual meeting of the National Safety council will be held in New York, Oct. 1-5 inclusive. Accident prevention executives will relate their experiences in the daily battle against carelessness. Meetings will be held in the Pennsylvania, Waldorf-Astoria, McAlpine, Martinique, and Commodore hotels. There will be no admission charge and nonmembers of the National Safety council are welcome to attend the various meetings.

The metals section of the council will meet at the Waldorf-Astoria on Oct. 1, immediately following the general meeting of delegates' roll call luncheon. Meetings will be held Monday afternoon, and Tuesday, Wednesday, and Thursday mornings. Safety and accident prevention in their various forms with relation to the production of the various metals and metal products will be discussed. Many personal observations and ideas will be brought forward and discussed. Of particular interest to the foundryman will be the paper presented by Nelson H. Kyser, safety engineer, Studebaker Corp. of America, South Bend, Ind., entitled "Correction of Unsafe Practices in Foundries."

J. A. Northwood, Bethlehem Steel Co., Johnstown, Pa., is chairman of the metals section and John P. Eib, Illinois Steel Co., Joliet, Ill., is secretary. Information on the coming meeting can be obtained from the latter.

Book Review

Progres de la Metallurgie et Leur Influence sur L'Aeronautique, by Gaetan Py, paper, 90 pages, 6¼ x 9½ inches, supplied by THE FOUNDRY, Cleveland, for 40 cents, and in London by the Penton Publishing Co. Ltd., 416-17 Caxton House, Westminster, for 5 francs.

The intense interest which has been aroused in recent years in aeronautical construction has resulted in a considerable development in research and practical results in light metals and alloys based on aluminum. The first chapter of the book deals with general progress in metallurgy. It describes various methods of studying the properties of metals and alloys, such as dilatometric measurements, X-rays, etc. It deals with recent studies on the physical properties of metals at high temperatures and the heat-treatment of light alloys. Before dealing with the various alloys used in airplane construction, the author devotes a few pages to the use of steel. Chapter II deals with the various methods of transforming or working up the metals, and reviews founding, drawing, rolling, forging, and heat-treatments. The second section of this chapter deals with machining, assembling, and protective coatings. Chapter III is specially devoted to the use of these metals and alloys in airplane construction. This book may be used as a convenient work of reference covering the present-day position of the use of light alloys in the construction of airplanes.

Electrochemists to Meet at Charleston

The American Electrochemical society will meet Sept. 20-22, at the Kanawha hotel, Charleston, W. Va., at which time an attractive program of scientific discussions and inspection trips will be offered. Visits will be made to several of the leading chemical industries of the district. The scientific program includes papers and discussions on many subjects including chemical reactions at high temperatures, electrodeposition, nickel plating and chromium plating.

Paul J. Kruesi is president of the society, and Colin G. Fink, Columbia university, New York, is secretary. Detailed programs and copies of the papers may be obtained from the secretary's office.

Plan Refractory Session

The fall meeting of the American Refractories institute will be held Oct. 24, 1928, at the William Penn hotel, Pittsburgh. Dorothy A. Texter, 2202 Oliver building, Pittsburgh, is secretary of the institute.

Foundrymen Decorated

The French government has awarded the decoration of the Legion of Honor to Leon Thomas, president of the Association Technique de Fonderie de Paris, and J. M. Espana, vice president and Spanish representative of the association, for services they have rendered the foundry industry.

Wants Castings

Charles H. Davis, 700 Pontiac street, Rochester, Ind., is in the market for about 500 cast-iron, park bench ends. He will be interested in having quotations on these castings.

L. P. Robinson, eastern representative of Sterling Wheelbarrow Co., Milwaukee, and Werner G. Smith Co., Cleveland, has moved from the Massachusetts Trust building to 541 Oliver building, 141 Milk street, Boston.

Obituary

Clarence H. Wahner, superintendent of the Paul E. Mueller Co., Milwaukee, died Aug. 13, after a day's illness. He was 40 years of age and a native of Milwaukee.

C. Kemble Baldwin, chief engineer of the Robins Conveying Belt Co., New York, died in Los Angeles, Aug. 9. Mr. Baldwin was graduated from Lehigh university in 1895 and had been associated with the Robins Co. since that time. He was a pioneer and an authority in this field.

Readers Comment

Note—Material appearing under this head does not necessarily reflect the opinion of THE FOUNDRY or of its editors.

To the Editors:

In a recent issue of THE FOUNDRY I noted a question from an iron foundryman regarding the iron backing up through the riser during the feeding operation. In my opinion your answer to the question is not satisfactory, and I submit the following explanation for the phenomenon.

There must be one of two causes for this trouble, either the metal or the sand. If the sand is not right, that is, if it is too wet or too hard, it would cause a violent commotion and result in a decided *blow*. From the evidence submitted by the questioner, I am inclined to the opinion that the trouble is with the metal. The foundryman should examine his iron thoroughly for oxidation. To test out this theory, he might use an extra amount either of fine ferromanganese or some aluminum alloy as a deoxidizer. With exceedingly hot metal this material may be added to the metal in the ladle while the stream is running from the spout of the cupola. Under other conditions, the material may be charged in lump form directly into the cupola with the pig iron and scrap. Lump spiegel added to each charge would supply a good practical solution to the problem. The trouble also may be caused by skimping on the limestone to an extent the cupola is not fluxed properly.

R. H. WEST

West Steel Casting Co., Cleveland.

W. G. Edmondson, assistant engineer of motive power of the Reading Co., has resigned to become works manager at the plant of the American Abrasive Metals Co., Irvington, N. J.

What the Foundries Are Doing

Reflecting the Activities of the Gray Iron, Malleable, Steel and Brass Shops

Plano Foundry Co., Plano, Ill., has increased its capital stock $100,000.

Alemite Die Casting & Mfg. Co., Chicago, has changed its name to the Alemite Metals Co.

Anderson Stove Co., Anderson, Ind., is operating full force and reports business good.

Hill-Curtis Co., Kalamazoo, Mich., has discontinued its foundry.

Chicago Hardware Foundry Co., Elkhart, Ind., plans the construction of a foundry addition to be used for a core room. (Noted July 1.)

Henry Vogt Machine Co., Louisville, plans the erection of an 8-story warehouse building at a cost of $350,000.

Henry Perkins Co., Bridgewater, Mass., plans to build a 1-story foundry on Broad street. The architect is not yet selected.

Federal Foundry Co., Indianapolis, has started to build shipping rooms, machine shops, and sand storage bins.

Atlas Foundry Co., Tacoma, Wash., was the successful bidder for furnishing cast iron specials for the extension of tide flats trunk main for the city of Tacoma.

Bay City Electric Castings Co., Bay City, Mich., suffered damage from a fire in its plant Aug. 19. The company officials contemplate rebuilding the burned plant.

Belle City Malleable Iron Co., Kewaunee street, Racine, Wis., has let contracts for the construction of an addition, 77 x 100 feet, to its annealing building.

Universal Foundry Co., Oshkosh, Wis., following increase in its capital from $50,000 to $100,000, has built an addition to its plant and has done extensive remodeling.

United States Aluminum Co., Post road, Fairfield, Conn., has awarded the contract for a 1 and 2-story plant and service building, 220 x 470 feet and 65 x 140 feet.

M. S. Little Mfg. Co., 151 New Park avenue, Hartford, Conn., has awarded the general contract for the construction of a 1-story brass foundry, 50 x 120 feet. (Noted Sept. 1.)

Wright Aeronautical Corp., 139 Railway avenue, Paterson, N. J., has awarded the general contract for a 2-story foundry to be built on Lewis street.

Lily Foundry Co., East Twenty-sixth street near Indiana avenue, Los Angeles, has been purchased by Crane Co., Chicago. The property consists of five acres improved with foundry and factory buildings.

Danville Iron & Steel Co., Danville, Pa., recently has been working night and day shifts. The company has received orders for pulverizing mills from the Studebaker Corp., South Bend, Ind., and the Lincoln Oil Co., Chicago.

National Foundry Co. Inc., Mobile, Ala., has been incorporated with $2000 capital to engage in the general foundry and machine shop business by Ferdinand Hackmeyer, F. William Hackmeyer and Bernard Scholtes.

Pontiac Pattern & Engineering Co., Pontiac, Mich., has awarded the contract for a foundry addition to Pryale Construction Co. Robert O. Derrick is the architect for the project. (Noted Aug. 15.)

Cleveland board of education, F. G. Hogen, director, plans to build a foundry addition at 535 Eagle avenue. G. M. Hopkinson, 310 Auditorium Garage building, Cleveland, is school architect.

Dominion Wheel & Foundries Ltd., Archibald street, St. Boniface, Man., has awarded contract to the Wyndels Construction Co. Ltd., 654 Aulneau street, for the erection of an addition to its plant, 1-story, 38 x 40 feet.

New Brass Ware Co. of Canada Ltd., 2320 Aird street, Montreal, Que., has let contract to the Dakin Construction Co., 270 Beaumont street, for the erection of a 1-story addition to its foundry to be 43 x 100 feet, steel and brick construction. Foundry equipment to be purchased later.

New Trade Publications

REFRACTORIES—The Ironton Fire Brick Co., Ironton, O., has issued a folder on plastic refractories for use as furnace linings.

STEEL ABRASIVES—A folder has been issued by the American Steel Abrasives Co., Galion, O., enumerating the advantages of its steel shot and steel grit as blasting materials.

MATERIAL HANDLING EQUIPMENT—A folder has been issued by the Cleveland Crane & Engineering Co., Wickliffe, O., illustrating different material handling devices.

AIR COMPRESSORS—The R. Planche & Co., Villefranche-s/Saone, Rhone, France, has issued a series of booklets describing various types of air compressors.

AIR COMPRESSORS—Angle compound air compressors are described and illustrated in a recent bulletin of the Sullivan Machinery Co., 122 South Michigan avenue, Chicago.

IRON CEMENTS—The Smooth-On Mfg. Co., 570-574 Communipaw avenue, Jersey City, N. J., has published a booklet on iron cements. It contains illustrations of the various uses of these compounds and directions for their application.

SWITCHES—The General Electric Co., Schenectady, N. Y., has issued a folder describing an enclosed magnetic switch. Included in this are the distinctive features and a graphical layout.

MOLDING EQUIPMENT—A new type of portable molding machine is described in a bulletin by the Osborn Mfg. Co., 5401 Hamilton avenue, Cleveland. The advantages of this type of machine are listed, and an illustration is shown portraying an advantageous arrangement.

SAND CONTROL—A catalog has been issued by Harry W. Dietert, Box 1506, Detroit, describing sand control equipment. It contains sketches and illustrations of the apparatus with a discussion of its care and assembly. It also has notes on the various properties of sand and a price list of the apparatus.

WELDING EQUIPMENT—The Fusion Welding Corp., 103rd street and Torrence avenue, Chicago, recently has issued a folder describing its new arc-welding apparatus. The design and advantages are discussed in detail, and the last page contains the general specifications for their units. The folder is well illustrated.

ACETYLENE GENERATORS—The Oxweld Acetylene Co., 30 East Forty-second street, New York, has issued a small booklet describing the construction and use of its low pressure acetylene generator. The numerous important features included in this generator are described.

METERS—The P. H. & F. M. Roots Co., Connersville, Ind., has published an 8-page booklet on gas meters. The principle of the positive displacement meter is reviewed and a new type meter is described and illustrated. The special indicating and recording instruments manufactured by this company are also discussed.

PUMPS—A 12-page catalog recently issued by the P. H. & F. M. Roots Co., Connersville, Ind., illustrates and describes the various pieces of apparatus made by them. The applications and characteristics of the different pieces of equipment are mentioned. Photographs of typical installations are shown.

CLEANING EQUIPMENT—A combination tumbling and blasting machine is described in a 4-page folder published by the American Foundry Equipment Co., Mishawaka, Ind. Photographs are used to show the mechanical features. A full description of the mechanism and advantages of this piece of equipment with a list of purchasers also is given.

WELDING EQUIPMENT—A 4-page folder has been issued by the General Electric Co., Schenectady, N. Y., announcing a new arc-welding machine. In this folder the apparatus has been fully described and its distinctive features, specifications, and uses listed. The folder also contains several illustrations of the equipment besides two photographs illustrating its uses.

CRANE CONTROL—The General Electric Co., Schenectady, N. Y., has issued a 26-page catalog explaining its method of control for direct current crane and mill motors. The publication explains this method graphically and illustrates its parts and installations with a number of photographs. It describes in detail how this system functions and its advantages.

CARS AND TRAILERS—The Lakewood Engineering Co., Cleveland, has issued a catalog describing and illustrating various types of cars and trailers. The company manufactures many types of dump, tunnel, platform, and special industrial cars, trailers of all types, skids, concrete buckets, and bin gates. The catalog is profusely illustrated and each product is fully described.

WELDING—The General Electric Co., Schenectady, N. Y., has issued a number of bulletins describing welding equipment. One publication is entitled "Arc Welding in Industry," a second is entitled "Arc Welding in General Electric Factories." Other bulletins describe a portable arc welding machine, a gas engine rivet machine and a welding resister for metallic welding.

FLUX—The Mathieson Alkali Works, Inc., 250 Park avenue, New York, has issued three bulletins dealing with various uses of its special flux. Bulletin No. 275 describes the use of this flux in cupola practice. Bulletin No. 287 deals with methods of desulphurizing with this flux by adding it to cast iron in the ladle. Bulletin No. 288 describes the use of the flux in brass melting.

AIR COMPRESSORS—R. Planche & Co., Villefranche-s/Saone, Rhone, France, has published a discussion of the various methods used to increase the efficiency of air compressors. The fore part of the book deals with the slider type of compressor. The remainder of the discussion deals with the principle and description of the rotary piston type. The article is quite technical, and in many instances, the point in question is proved mathematically. It is well illustrated by sketches and photographs, each being described in detail. The rear portion of the book is devoted to descriptions of regulators, and to photographs of equipment manufactured by R. Planche & Co.